A STUDY ON GENETIC DEMOGRAPHY OF THE KSHATRIYAS

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D53

Dedicated to

My Beloved Mother

DECLARATION

The present thesis entitled "A STUDY ON THE GENETIC DEMOGRAPHY OF THE KSHATRIYAS" *is the original work and has been carried out by me in the department of Human Genetics, Andhra University, Waltair, under the joint supervision of* ***Professor P.Veerraju*** *and* ***Professor T.Venkateswara Rao****. No Part of this thesis has been submitted for the award of any degree or diploma.*

Visakhapatnam,

Date:02nd November 2001 ***(B.Dharani Priya)***

Certificate

This is to certify that the present Ph.D. thesis entitled "A STUDY ON THE GENETIC DEMOGRAPHY OF THE KSHATRIYAS" *is the outcome of original field research work in north coastal Andhra Pradesh, India, carried out by* ***Mrs B.Dharani Priya, M.sc.****, GATE-UGC: research fellow, department of Human Genetics, Andhra University, Waltair.*

We have pleasure in certifying that this is a genuine and bonafide work of Mrs. B.Dharani Priya, under our joint supervision.

27/11/2001

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LIST OF ABBREVIATIONS

TNW	Total number of women
TNCps	Total number of conceptions
TNLbs	Total number of live births
TNSch	Total number of surviving children
TNPNDs	Total number of prenatal deaths
TNPRDs	Total number of pre reproductive deaths
TNAbs	Total number of abortions
TNSbs	Total number of still births
TNNDs	Total number of neonatal deaths
TNIDs	Total number of infant
TNJDs	Total number of juvenile deaths
A	Affinal
CM	Consanguineous marriage
UN	Uncle-niece
FC	First cousins
FCOR	First cousin once removed
SC	Second Cousins

CHAPTER–1

INTRODUCTION

POPULATION GENETICS

Population genetics is a branch of science, which deals with the genetic variation in defined populations, including relevant aspects of population structure and geographic variability of DNA sequences and their frequencies. Their changes in time and space are controlled by evolutionary factors, among which population geneticists recognize as most important: mutation, natural selection (i.e. differential mortality and fertility of genetic types), drift (stochastic fluctuation tied to the demographic size of populations) and migration. Population genetics deals with the characteristics of genes within a population instead of describing the genes in a particular individual. The term population genetics applies to all living organisms. The major aspects of human population genetics deal with the implications of how Mendel's laws and other genetic principles affect the entire populations. Such a study is essential to proper understanding of evolution, because fundamentally, evolution is the result of progressive change in the genetic composition of a population.

Today the students of human biology are more concerned with the dynamic aspects of human population structure and the micro evolutionary forces operating on them.

Creation of a new human being at fertilization is in the form of a single cell. It carries full complement of hereditary information. This single cell multiplies and forms into number of new cells, which perform specific functions. All these take place in a determined sequence, embryonic development, growth, senescence and then death.

Therefore, all the information required for the above events to occur is present in a single cell. Each half of this information comes from egg and spermatozoan. So, for the chromosomes of the cells, they carry all the instructions to the development of an individual or particular human being. The genetic information, which the new individual receives, is the basis of his individuality. It distinguishes him from all other individuals. No man now or in the past has had precisely the same genes as another. Recent studies (Charles Cantor, 2000) are showing that except for genetically identical siblings, each of us differ from other humans at up to 20 million sites in the genome. It was originally estimated that about one in thousand (1 in 1000) of these sites called nucleotides (the chemical components of DNA) varies from person to person.

Finally the development of individual is greatly influenced by his environment for his final size. Therefore, the end result of the individual developmental process depends on random events in his environment, but the effects of these events obey probability distribution that depends on the genetic information brought together at his conception.

Each individual passes only half of his genes to any one of the offspring. It is a matter of chance, which of these genes are received to form the character.

In a large population, the genetic heritage is maintained through the generations. In each generation, the genes are segregated in gametes and come together in new combinations in the individuals. A common heritage is therefore concealed behind the diversity of the individuals of a given population.

The units of information carried in the chromosomes are passed through the generations, often unexpressed and hidden, alternately separated and paired up together according to the chances of fertilizations but always preserved unchanged. So, the fundamental property of population is its common genetic heritage.

Contribution of each individual has a small effect on his common heritage. He bears the genetic information in larger or smaller proportion in the next generation depending on his offspring, many or few. In this way, frequency of any particular unit of information can change from one generation to the next.

Population genetics deals with the study of these changes. The aim of population genetics is to study changes in the genetic heritage, at the population level. It is concerned with understanding the nature and source of these inherited differences (genes), and also with predicting the changes that may take place in the relative frequencies of the different genotypes that may be found in a population, and also with determining the conditions under which equilibrium between the forces affecting their frequencies may be obtained. The change in gene and genotype frequencies is the basis of evolution. The important factors which influence the change of gene frequencies are selection, genetic drift, non-random mating, migration (gene flow) or mutation, which bring genetic variation in man. The genetic variation is the fundamental basis of evolution. This is because the evolutionary potential of a gene, genome, genotype, phenotype, organism or population is a function of the amount of the mutation rate and the hereditary variation present in it at a given time.

To study the genetic differentiation process in man we require a reliable population data. A Mendelian population is a population, in which the members share a common environment, interbreed among themselves and share a common gene pool in which the characters follow the Mendelian principles of inheritance. It is a reproductive or evolutionary unit and any change in its genetic profile from one generation to next will constitute an evolutionary change. The three pioneers, R.A.Fisher, J.B.S.Haldane and Sewal Wright constructed a remarkable foundation for gene and evolution with mathematical theory and by quantitative predictions.

Microevolution is slight changes in gene frequencies or modifications in morphological traits that occur generation by generation thereby differentiating the descendent population from the ancestral one (Das, 1985). Although the studies of experimental population genetics are necessarily restricted to short periods of time and usually limited geographical areas, such micro evolutionary studies could nevertheless help greatly in understanding the general phenomena of evolution on a large time scale namely macroevolution. Because macroevolution is a creative process, it involves radical changes in body structures and functions, connected with adaptation to new modes of life and with complete reproductive isolation. It leads to the formation of new species, genera, families and higher strata. Such changes require time on the geological scale. Macro evolutionary changes are neither repeatable nor reversible whereas microevolutionary changes, at least in principle are reproducible, repeatable and reversible.

The human genetic variation plays a significant role in bringing about the diversity in population structure and contributes to the dynamics of human evolution The genetic similarities between populations show the common origin or the admixture of the gene pools The genetic heterogeneity between the populations indicates the diversity of origin or the isolation by some known barriers

The human populations are classified into four groups viz ,Australoids, Caucasoids, Mongoloids and Negroids by Physical Anthropologists and Population Geneticists on the basis of morphological characters and pigmentation Now polymorphisms of many genetical traits are considered useful tools for differentiation of human populations (Roychoudhury,1983) Unlike morphological polymorphisms serological and bio-chemical polymorphisms are independent of the influence of environment Modern genetic studies are based on the molecular analysis of DNA polymorphism developed to study individual and racial differences in man All these parameters are useful to trace ancestry, admixture and affinity of different groups of people

The people of India are classified into four types based on their morphological characters (Malhotra, 1978)

Negrito – they are now confined to the Andaman Islands and Nilgiri hills.

Australoids – they are chiefly distributed in central and southern regions of India.

Mongoloids – they are found primarily in northeast region and also at sub-Himalayan regions of India.

Caucasoid – they are spread throughout India.

To understand microevolutionary process, we have to examine underlying demographic factors, what Bogue (1969) has termed demographic processes – fertility, mortality, marriage type, migration etc., responsible for the observed population composition and structure.

The genic or genetic contribution of an individual to next generation is a function of fertility and mortality in the parental generation. In other words it is the fitness value of an individual or population, which is a function of the net reproductive rate (NRR). Again the NRR is a function of age specific fertility and mortality.

Knowledge in human population genetics is important in a whole variety of disciplines related to human biology and human welfare.

GENETIC DEMOGRAPHY

Most important role of genetic demographer is the prediction of the future course of population changes; also realize the need to take account of population genetic principles and especially of the family as the unit of information, in making his prediction.

Demography in its broadest sense is simply the statistical study of human populations. Study of genetic composition of populations in the light of demographic changes in populations may be described as genetic demography..

Each and every existing human population has a definite demographic structure, age composition and sex composition which fluctuate with time, but which can be described at any given moment with the help of number of births, deaths, migration etc.,.

Genetic demography deals with marriage system, inbreeding, effective population size, fertility, mortality, marital distance etc., which influence the genetic diversity of the population with the help of which one can find out how the genes are distributed and combined within populations.

DEMOGRAPHIC PARAMETERS:

Menarche:

The term 'Menarche' was introduced into medical literature by Kisch in 1910 to denote the period of life in which as a sign of puberty, menstruation makes its first appearance in female life. It is an important event in the physiological life of a female, representing a definite stage after which she could become capable of conceiving.

According to Tanner (1960,1962) the menarcheal age depends on the combined action of genes at many different loci rather than a single gene. He further says that the onset of first menstruation depends upon several factors such as socio-economic levels, ecological conditions, genetic background, moral and psychic environment, etc. Variation in the age of menarche has aroused interest in the minds of scientists all over the world to carry out studies in different populations, keeping in view the factors such as genetic, environmental, climatic, nutritional and socio-economic status.

Marriage pattern:

India is characterized by the presence of a large number of endogamous castes, tribes and religious communities with different types of marriage practices. The pattern of marriage in India is generally followed by three important regulations, viz.,

Endogamy

Exogamy

Consanguineous or Sapinda marriage

There is a greater incidence of consanguineous marriages among the populations of the southern states, Muslim groups, Parsees and various tribal communities (Basu, 1985).

Consanguineous marriages may result in an increased probability of abortions, miscarriages, stillbirths, neo-natal deaths, infant and juvenile deaths, physical and mental defects, susceptibility to infectious diseases etc. Consanguinity and large family size are very interesting for population genetic studies.

It is interesting to study the patterns of genetic affinities among endogamous groups inhabiting smaller geographic regions. Marriages in the Hindu society are regulated by historical social norms. These norms play a significant role in influencing exchange of genes within them and between endogamous groups.

A person born to Hindu parents belongs by birth to one of four hierarchical groups known as varnas. At the top of this hierarchical social organization are the Brahmins followed by Kshatriyas, Vaisyas, and Sudras. Each varna comprises several castes (kulas), each of which is an endogamous unit. Most of the castes comprise gotra which are generally patrilineally transmitted. But among some castes the transmission is matrilineal, for example Nairs of Kerala.

In Southern India, marriages between certain types of biological relatives (e.g. U-N and FC) are preferred. The practice of consanguinity in Southern India results in increase in the frequency of individuals who are homozygous for genes i.e., identical by descent.

Marriage age:

The practice of early marriage of girls is still widely followed in India. In the Indian socio-cultural system, after marriage, a woman will become pregnant as soon as possible. It leads to early maternity and higher adolescent fertility.

The patterns of age at marriage, which have been changing in several countries, can have selective consequences, for instance with respect to deleterious traits that have an age of onset that is approximately the same as the marriage age, such as schizophrenia. Onset of these diseases considerably decreases the chance of marriage. A decrease in the age of marriage, therefore, increases the fitness of persons destined to have such diseases and an increase in age at marriage decreases their fitness. The frequencies of abortions, miscarriages and stillbirths are to be much higher in younger mothers below the age of 19 years. The same condition can also be seen in older women whose marriage age is above 30 years.

The cultural norms that particularly affect women's health are attitudes towards marriage, marriage practices, age at marriage, values attached to fertility and sex of the child, pattern of family organization, her *status in the society*, *decision making capability*, *ideal* role demanded of women by social and cultural conventions. All these determine the women's place in the family, her access to medical care, education, nutrition and other health resources.

Menopause:

The term menopause was introduced in 1821 by Gardanne. It refers to the cessation of menstruation (i.e. the end of the reproductive life), but commonly used to refer to the period of the female climacteric. Menses stop naturally with the decline of cyclic hormonal production and function between 45 and 60 years of age but may stop earlier in life as a result of illness or the surgical removal of uterus (hysterectomy) or both ovaries (ovariectomy).

As the production of ovarian estrogen and pituitary gonadotropins decreases, ovulation and menstruation become less frequent and eventually stop. Fluctuations in the circulating levels of these hormones occur as the levels decline. Hot flashes are the only nearly universal symptom of the menopause. They can often be controlled with estrogen but sometimes so severe as to require therapy and will cease in time without hormonal treatment.

Occasionally, heavy irregular bleeding occurs at this time, usually associated with myomata or other uterine pathologic conditions. Estrogens given in large parental doses may be effective, but hysterectomy is sometimes required for control of the bleeding (Mosby's medical dictionary, 1992).

The end of reproductive life is of considerable interest for diverse reasons not only because women may wish to postpone or prolong child bearing. But evolutionary biologists, demographers and biometricians have an interest in describing and predicting fertility trends in these women. Genetic epidemiologists can enhance the value of epidemiological research by incorporating information about genetic differences in risk into accurate statistical prediction of the time of menopause

The paper by Harold Snieder and colleagues from the Twin Research unit at St.Thomas Hospital, London is the first to identify a substantial proportion of variance of age at natural menopause attributable to genetic influences. The recent reports of Susan (1998) show that the age at menopause is closer between monozygotic twins than between dizygotic twins.

Usually post menopause women are having high risk for diseases such as cardiovascular and osteoporosis due to decreased estrogen concentration Delaying menopause in certain women may have low risk on such diseases

Fertility and Mortality:

Fertility and mortality are important demographic parameters controlling population growth

Fertility is the ability to reproduce Fertility rates are generally lower in developed nations than in underdeveloped nations Natural selection plays a significant role through fertility and mortality

Mortality is the condition of being subject to death The death rate, which reflects the number of deaths per unit of population in any specific region, age group, disease or other classification, is usually expressed as death per 1000, 10,000 or 100,000 (Mosby's medical dictionary, 1992)

India has shown a considerable decrease in mortality statistics over years The main reasons for this are overall social development, higher autonomy of women (Dyson and Moore, 1983), changed social values (Cald well et al 1983), improved health measures, improved sanitary conditions, eradication of many epidemic diseases and several laws and policies of the State Even factors like religious affiliation, education, occupation, urban and rural residence

Genetic structure of a population is greatly influenced by differential fertility and differential survival of genotypes

Sterility:

Sterility refers to the female, who is unable to produce children because of a physical abnormality – often the absence of spermatogenesis in a man or blockage of the fallopian tubes in a woman (Mosby's medical dictionary, 1992).

It plays a dual role in population differentiation. It increase variance of fertility and thereby renders natural selection more effective role. Through fertility differentiation on the other hand, it reduces effective population size and increases the random genetic heterogeneity of population.

Natural Selection:

The study of the populations, in particular how they survive, die, and reproduce or grow is called Demography. The measurement of natural selection involves the chances of survival and reproduction of individuals that have different genotypes. The main difference is that demography involves the study of the populations as a whole, whereas natural selection acts on groups of individuals, defined by their genotypes, who form only a part of a population. To observe the specific reasons as to why some genotypes have higher and lower mortalities or fertilities, the biochemical, physiological, ecological methods had been useful. But the measurement of the intensity of natural selection uses demographic techniques to estimate the mortalities and fertilities and does not depend on the underlying mechanisms.

Natural selection is the process by which genotypes with greater fitness leaves more offspring than do less fit genotypes. Because of natural selection, those favorable alleles that promote higher fitness will be represented disproportionally in the next and succeeding generations. As these favorable alleles increase in frequency in the population more of the fitter genotypes will be formed, and the types and frequencies of alleles in the population will gradually change, so as to promote greater adaptation to the environment.

The process of natural selection, which leads to increased adaptation of organisms to their environment, is often called microevolution.

It is identified by the fertility and mortality rates of different genotypes. It depends on various factors such as somatic vigour, fecundity and efficiency of impregnation. It also depends on the social and physical conditions of environment.

Natural selection has been classified according to the effects it may be expected to produce on genotypic and phenotypic levels and these are as follows (Jha,1997):

Disruptive Selection (Mather, 1953) or Centrifugal Selection (Simpson,1944): The presence of a gene or gene arrangement in one locality and its absence in the population of the same species living in another locality is an instance of disruptive selection. Most populations occupy quite a heterogeneous environment and are, therefore, exposed to disruptive selection.

Cyclic Selection (Thoday, 1953): populations exposed to heterogeneous environments are also subject to cyclic seasonal changes so that the population will also be exposed to cyclic selection. A population may change in the relative frequencies of a gene or gene arrangement with the changing conditions of the environment in which it lives.

Stabilizing Selection (Mather, 1953) or Centripetal Selection (Simpson, 1944): Stabilizing selection in a population is to maintain balanced polymorphism, whereby the heterozygotes are superior to the *corresponding homozygotes. Polymorphism may be* frequently adaptive.

Directional Selection (Mather, 1953): Selection may also be expected to lead to fixation of a gene or gene arrangement by increasing its frequency in a particular direction, up to 100%. This is called directional selection.

INBREEDING:

Inbreeding means the mating together of individuals that are genetically related to each other by ancestry. The degree of relationship between the individuals in a population depends on the size of the population that will be clear by consideration of the number of possible ancestors.

Two individuals are said to be consanguineous, if they have at least one common ancestor and their offspring are said to be inbred. Among such offspring there is a higher frequency of diseases and defects determined by rare recessive genes as compared to their non-inbred counterparts. The increase in homozygosity comes about because of shared ancestry; a specific deleterious allele, from a joint forebear can be successively replicated and transmitted through both lines of descent to mates who are related to their offspring. Two alleles that have a common history are said to be identical by descent. They not only code for the polypeptide but also trace back to exactly the same segment of DNA in a common ancestor.

The usual measure of inbreeding, called the coefficient of inbreeding 'F', is the probability that an individual receives at a given locus two genes that are identical by descent (Malecot, 1948). The coefficient F, was originally invented by much honored and by long lived American Geneticist Sewal Wright (1921,1922), and he was the main pioneer of studies of effects of inbreeding. An individual who is homozygous for a given genes carries at a certain locus two homologous genes that are physically identical but not necessarily identical by descent. This physical identity is called identity by nature. Inbreeding makes an individual homozygous for genes that are identical by descent.

Proportion of shared genes that are distributed among different relationships and coefficient of inbreeding of their children is given in the table.1.1.

Table 1.1

Coefficients of Inbreeding in different degrees of relationships

Type of relationship	Degree of Relationship	Genes in common	Coefficient of Inbreeding
MZ twins	----	1	----
Parent-child	1st Degree	½	¼
Brother-sister (including DZ twins)	1St Degree	½	¼
Brother half sister	2nd Degree	¼	¼
Uncle-niece or Aunt-nephew	2nd Degree	¼	1/8
Half uncle niece	3rd Degree	1/8	1/16
First cousins	3rd Degree	1/8	1/16
Double first cousins	2nd Degree	¼	1/8
Half first cousins	4th Degree	1/16	1/32
First cousins once removed	4th Degree	1/16	1/32
Second cousins	5th Degree	1/32	1/64
Second cousins once removed	6th Degree	1/64	1/128
Third cousins	6th Degree	1/128	1/256

Inbreeding rates vary widely in human population. The highest coefficient of inbreeding is found in India, Japan, Brazil and Israel. The lowest one is in the United States (Freire-Maia, 1967). No homogeneity exists within a country, a province or even a township. A number of factors are known as capable of influencing the occurrence of consanguineous marriages – cultural pattern, economic level, migration, population density, degree of ruralization, etc. The exact degree of relationship at which mating is considered incestuous may differ slightly from one society to another, but parent offspring and brother sister mating are forbidden in all societies.

Some of the geographical regions and practices of consanguineous marriages are as following: -

Geographical regions	**Marriage types**
Middle East (especially Saudi Arabia, Kuwait and Jordan)	Over half of all marriages are consanguineous The most common type of consanguineous marriage is that of patrilateral first cousins
Syria, Israel (Arab community), Algeria, Lebanon, Egypt, Pakistan	More than 1 in 4 marriages are consanguineous
Japan & Brazil	Almost 1 in 20 marriages are consanguineous

Hindu (India)	U-N marriage is the most common type of consanguineous marriage
China	Patrilateral FC marriage (between children of two brothers) is prohibited, other types of first cousin marriages are allowed
Jewish	U-N & FC marriage is allowed
US	FC marriage among people of reproductive age is not allowed, consanguineous marriage nevertheless occurs in Middle Eastern & South Asian immigrant & some religions communities (e g order Amish Hutterites & Gypsies)

The effects of inbreeding are most pronounced on diseases and defects, which are determined by rare recessive deleterious genes. rarer the gene, more pronounced is the effect. Such data has been reported from Western countries and Japan on conditions like Albinism, Tay Sachs disease, Ichthyosis congenita and Xeroderma pigmentosum (Stern,1960). Significant association was found between consanguinity and neural tube defects in Bombay and in Alexandria (Stevenson et.al.1966).

Consequences of Inbreeding:

Number of studies are showing higher birthrate among the consanguineous couples as compared to non consanguineous couples (Schull et al ,1970, Reid,1971, Mukherjee et al ,1974) Studies in the United States (Eaton and Mayor,1954, Pearson,1902, Fisher,1949), in Europe (Darwin,1875, Book,1956, Darlington,1960), in South America (Freire-Maia and Azeveda,1971) and in Japan (Schull et al ,1970, Schull and Neel,1972, Yamamoto et al ,1972) and also in India (Reid,1973, Mukherjee et al ,1974, Basu,1975, Ramesh,1979,) And in French Canadian populations (Philippe,1974) have revealed higher fertility rates among consanguineous couples than among non consanguineous couples

A few studies in the United States (Arner,1908,Slatis et al ,1958), in Europe (Sutter and Tabah,1952), in Kurdistan Jews (Goldschmidt et al ,1963), in India (Rao and Inbaraj,1977) and in Jordan (Cook and Hanslip,1966) have shown that there is no differences in fertility levels among consanguineous and non-consanguineous couples

More number of studies all over the world are showing elevated levels of prereproductive mortality among the offspring of consanguineous marriages (Bemiss,1858, Arner,1908, Slatis et al ,1958, Schull and Neel 1965, 1966, Freire-Maia 1963, Freire-

Maia and Krieger 1963, Hussain,1971, Seemanova,1971, Book,1957, Sutter and Tabah,1952, Kumar et al ,1967,Reid,1971, Murthy and Jamil, 1972, Mukherjee et al 1974, Reddy and Naidu, 1978 Ramesh 1979)

Though the differences are not statistically significant, Tanner (1958) reported that in the Bondei of Tanzania the mortality rate among the children born to unrelated parents (34 3%) is higher than the children born to related parents (32 1%)

Cook and Hanslip (1966), Roberts and Bonne (1973) and Reid (1976) have found that consanguinity has no influence on the mortality of offspring

The impact of consanguineous unions on prenatal mortality (abortions, miscarriages and still births) also varies A decreased frequency of prenatal mortality among related as compared to unrelated couples has been reported by Book (1957), Marcallo et al ,(1964), Goldschimidt et al ,(1963), Larrine and Waller (1946), Golovachev and Bokorians (1971) and Peritz (1971) attributed this to lesser immuno incompatibility among consanguineous couples

Philippe (1974) has also observed relationship between prenatal mortality and parental consanguinity However, an increased frequency of prenatal mortality among related couples has been reported by Sutter and Tabah (1952), Kumar et al ,(1967), Basu (1975) and Rao and Inbaraj (1977)

Inbreeding in India and its genetic consequences

India provides unique opportunities to pursue studies on this problem. We have a large population with high degree of inbreeding and available evidences indicate that for many of the populations, these practices were of long duration in the past, going back to pre-Christian era and even to the Neolithic period in the South.

Several studies reported high frequency of consanguineous marriages in Maharastra and Andhra Pradesh. In Maharastra, the frequency is 12% in Hindus, 18% in Parses,26% in Muslim groups and 4.5% in Christians (Sanghvi,1975). In Andhra Pradesh the frequency of consanguineous marriages is as high as 40% with U-N marriages constituting almost 10% (Sanghvi et.al.,1956). A high frequency of consanguinity has been reported among tribal and non-tribal population of Andhra Pradesh (Sanghvi,1966; Veerraju,1971,1978).

Effects of inbreeding have been studied on mortality, selection intensity and anthropometric traits in socio-economically diverge castes(Murthy and Rao,1996).

Only few studies have been carried out in India on effects of inbreeding on morbidity and mortality. Dronamraju and Meerakhan (1961), reported their findings in a study of 605 patients in a hospital of Andhra Pradesh. Though the samples for most of the diseases and defects were small, they claimed a significant effect of inbreeding in pulmonary tuberculosis. Kumar et.al.,(1967), reported their findings in a study of 276 families with 1195 pregnancy histories from different hospitals in Kerala They claimed significant effect of inbreeding in early mortality

Significant association between parental consanguinity and early mortality, congenital malformation and birth weight was reported by Magnus et al ,(1985)

According to Rao (1983), Hindus have the highest inbreeding coefficient as compared to Muslims or Christians for both autosomal and sex-linked genes, but there were significant variations among the different castes In one study of several caste groups (representating very different socio economic levels), about 19% of all marriages were between U-N and another 22% were between first cousins (Reddy,1987) Theoretically, long continued inbreeding with high intensity should reduce the frequency of lethal and deleterious genes in population

Rao and Murthy (1984,1986) studied the effects of inbreeding on mortality and selection intensities in different population groups of Andhra Pradesh, and observed higher mortality load in the forward castes and lower in the scheduled castes

GENETIC LOAD:

Genetic load is defined as the relative decrease in the average fitness of a population, with respect to the fitness it would have if all individuals in the population had the genotype that has maximum fitness (Crow, 1958). The load is considered as mutational or segregational depending on genes that are deleterious when homozygous in the following circumstances (Muller, 1950):

Genes those are not (or only moderately) deleterious when heterozygous:- The fitness of the genotypes AA and Aa are almost the same with genotype 'aa' that is at a disadvantage. Under such conditions, the gene frequency of 'a' is kept low by the balance between mutation and selection the loss of zygote due to such loci is called the mutational load.

Genes for which the heterozygote is the fittest genotype compared to either homozygote:- such genes become polymorphic, so that, either of the alleles can attain relatively high frequency. They are often called over dominant. The genetic load due to over dominant loci is known as the segregational load. Sickle cell Hemoglobin is one of the best examples of over dominant loci in human population.

Some genotypes have a reduced fitness with certain parents. For e.g. a zygote of blood group A seems to have a better chance of surviving if its mother group is A1 rather than group O. Such incompatibility may possibly account for substantial fraction of

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human embryonic deaths, which is called as the incompatibility load.

According to Freire-Maia (1976), there are about 17 types of genetic loads in man out of which the mutational load is the most important one. Morton et.al.,(1965) introduced the idea of B/A ratio, where B referred to the inbred load and A to the random load.

Genetic load can be estimated by regression of inbreeding on mortality, as homozygotes in both classes of genes will occur with increased frequency in the progeny of consanguineous mating and thus the average fitness of the population will decrease with inbreeding (Cavalli-Sforza and Bodmer,1971).

CHAPTER–2

ETHNOGRAPHIC NOTE ON THE KSHATRIYAS

INDIA:

India is a large country in Southern Asia. It is the second largest country in the world in population. The river valleys of North Eastern India are among the most densely populated places in the World. India ranks seventh in the world area.

India covers an area of 3,287,263 square kilometers. Great Mountains separate most of Northern India from the rest of Asia. The Southern half is a triangular peninsula that extends into the Indian Ocean. The Arabian Sea lies to the west of India, and the Bay of Bengal to the East. The coastline is 6,483 kilometers, of which 1,312 kilometers belongs to Island territories. India has three main land regions: The Himalayas, The Northern Plains and the Deccan or Southern Plateau.

India is a great land with great number of races, communities and religions, enormous genetic diversity and its populations spread over different regions.

According to 1991 census, population of India is 843,930,861, which is ¼th of total population of the world. As per present reading of the world population reported on the eve of “World Population Day” celebrated in the ‘second week of July 2000’ as reported in various articles, dailies & other publications the world population touched 6,05,92,28,435 (i.e.

approximately 606 crores) on May 11th 2000, the population of India touched 100 crores and it is expected to reach 152 crores by 2050

India supports one sixth (1/6th) of the world's population with only 2 4% of the world's land area It is the second largest country in the world, next to China in terms of population

About 73% of India's people live in rural areas The people of India speak in 14 major languages and more than 1000 minor languages and dialects About 83% of the Indian people are Hindus and about 11% are Muslims The next largest religious groups, in order of size are Christians, Sikhs, Buddhists and Jains

India was a British colony from the late 1700's until it gained independence in 1947 Since then, the Indian government has been trying to develop the country's resources and improve the standard of living For example, the development of new varieties of seeds and the improved use of fertilizers and irrigation with the help of modern technology, improved medical facilities to control the many contagious and non-contagious diseases As a result, there has been no major famine in India since independence and life expectancy has risen by about 25 years

ANDHRA PRADESH

Andhra Pradesh is the fifth largest state in India and also large state in South Eastern India Set in the heart of peninsular India, it lies entirely within the tropics It has a longer stretch of coastline than any other Indian state The Bay of Bengal forms the Eastern boundary of the state To the North East is Orissa, and on the North and North West borders are the states of Madhya Pradesh and Maharastra Karnataka forms the Western border with Tamil Nadu to the South The state capital is Hyderabad It is India's sixth largest city and the largest city in Andhra Pradesh It consists of 23 districts

Andhra Pradesh is a land of ancient people In 'Sathapatha Brahmana' 'Andhra' is referred These distinct references to these people and region are also found in Ramayana and Mahabharatha Satavahana established their independent state in Andhra Pradesh The historic Satavahana (230 BC to 200 AD), Kakatiya (1081-1323) and Vijayanagar empires (mid 1300's) have ruled over vast territories in the south and developed the region to great social, cultural and economic heights of achievements

Andhra Pradesh was previously a part of Madras presidency under British rule After independence in due course it was separated from Madras presidency first and later together with eight districts of erstwhile Nizam dominion was constituted into Andhra Pradesh in 1956.

As per 1991 census, the population of Andhra Pradesh is 66.5 million. It is mostly an agricultural based state. Nearly 80 percent of the people of Andhra Pradesh live in villages, about 9 percent of the population are tribal, living in remote areas of the state. Nearly 90 per cent of the people of Andhra Pradesh are Hindus and the rest make up Muslim, Christians and others. More than 85 per cent of the population speaks Telugu.

The average age at marriage for girls in Andhra Pradesh has also shown a gradual improvement from 16 years in 1971 to 17.6 years in 1991 and 17.8 years in 1993.

The birth rate in Andhra Pradesh, which was around 31 per 1000 population in 1981 came down to 26 by 1991 & further, came down to 22.5 in 1997. Andhra Pradesh is one of the states actively implementing family planning program.

The infant mortality rate, which was around 81 per 1000 live births in 1981, came down to 73 in 1991 and further down to 63 in 1997.

The socio cultural factors of Andhra Pradesh reveal that couples have tendency to begin their reproductive activity at an early age and complete their desired family size also at an early period The mean age of acceptance of sterilization is 26 4 years in Andhra Pradesh, while it is 30 years for rest of India

As per the 'National Family Health Survey – 1'(NFHS-1, 1984-91) in Andhra Pradesh, the total fertility rate (TFR, the average number of children born per woman) is 2 59 and as per NFHS-2 (1996-1998) it is 2 25 which is slightly higher than the desired TFR i e 2 1

The female literacy rate is low in the state (33 7%) Nearly 78% of the girls are dropouts from school by the time they reach 8th standard This obviously leads to low age at marriage for girls Though the mortality is coming down the infant and child mortality is still on the higher side with regard to Andhra Pradesh, which may adversely affect the family planning program

Andhra Pradesh is the first state in India to bring out a comprehensive policy to cope health, family welfare, women and child development including nutrition The family welfare department needs support from other departments for reducing population growth or birth rate There are other associated factors, particularly female age at marriage, female literacy and child labor practices.

Kshatriya – Population of the present study:

The Indian sub continent comprises a vast collection of peoples with the different morphological, genetic, cultural and linguistic characteristics.

In an ancestral population of a given area with the passage of time there is fission of the population into many sub populations. Such fissions primarily occur because of various cultural and demographic reasons. The demographic impact of such fissions is an increase in genetic diversity among sub population because of genetic drift.

The people of India are socially organized into distinct groups that are largely endogamous, reproductively isolated. The vast majority practice Hinduism and follow the Hindu caste system. The level of caste endogamy is currently highly variable (Malhotra & Vasulu 1993), perhaps was variable in historical times too.

Traditionally, each caste tended to pursue a hereditarily prescribed occupation and were linked to each other through a determined patterns of barter of services and produce (Karve 1961).

The subject matter of the present thesis is about the set of Kshatriya community. Many eminent authors expressed various views on Kshatriya community. Pandit Madiraju Venkataraju, 1989, in his book 'Kshatriyanwaya Samiksha', attempted to trace the history and provided lot of information about Kshatriyas. According to his text, the concise information is given below.

Originally there was only one clan or Varna described as Kshatriya Varna or Kshatra Varna, which may be broadly named as warrior clan or warrior race. Later it split into two distinct categories called Surya vamsa and Chandra vamsa i.e. Solar dynasty or Lunar dynasty respectively. Both the dynasties originated from Vyvaswata Manu. Ikshwaku was his eldest son who was the progenitor of Solar dynasty and ruled over a vast territory of land. The rule of this dynasty came to an end with Sumitra.

The grandson (Vyvaswata Manu's daughter's son) Pururava was the first ruler of Lunar dynasty. This dynasty ended with Bruhatchatra. The Kshatriya clan was later divided into 32 branches. Thereafter the history of later Kshatriyas could not be traced. Of them three distinct branches are known well, namely Solar, Lunar and Agnikula (born out sacrificial fire).

The present study is limited to Kshatriya caste, which we cannot identify with any one of the three categories, though they claim to be the descendents of one or the other above mentioned three distinct groups

It occupies the second hierarchical place in Hindu society Though earlier their vocational pursuits were limited to learning martial arts, besides other formal branches of learning and also engaging themselves in the executive part of social order to keep up an orderly society Now since several centuries they are up mostly in agriculture and also involving in other occupations as well It is numerically a small community They are well known among the public as 'Rajus'

Area of Present Study:

The present work was attempted in four coastal districts of Andhra Pradesh viz , Visakhapatnam, Vijayanagaram, East Godavari and West Godavari districts during the period of 1997-99

Visakhapatnam, popularly known as Vizag was once a small fishing village named after Vaisakha, the God of valor Today it is a bustling industrial and naval port city

Vijayanagaram is an important cultural center, which was the capital of the Rajas of Vijayanagaram during the 17th century. During their period, art and culture flourished greatly.

East Godavari district is in the North Eastern part of Andhra Pradesh, with the Bay of Bengal on the East and the river Godavari has its natural boundaries in the South. Kakinada, the head quarters of the district, is on the Western side Koringa Bay.

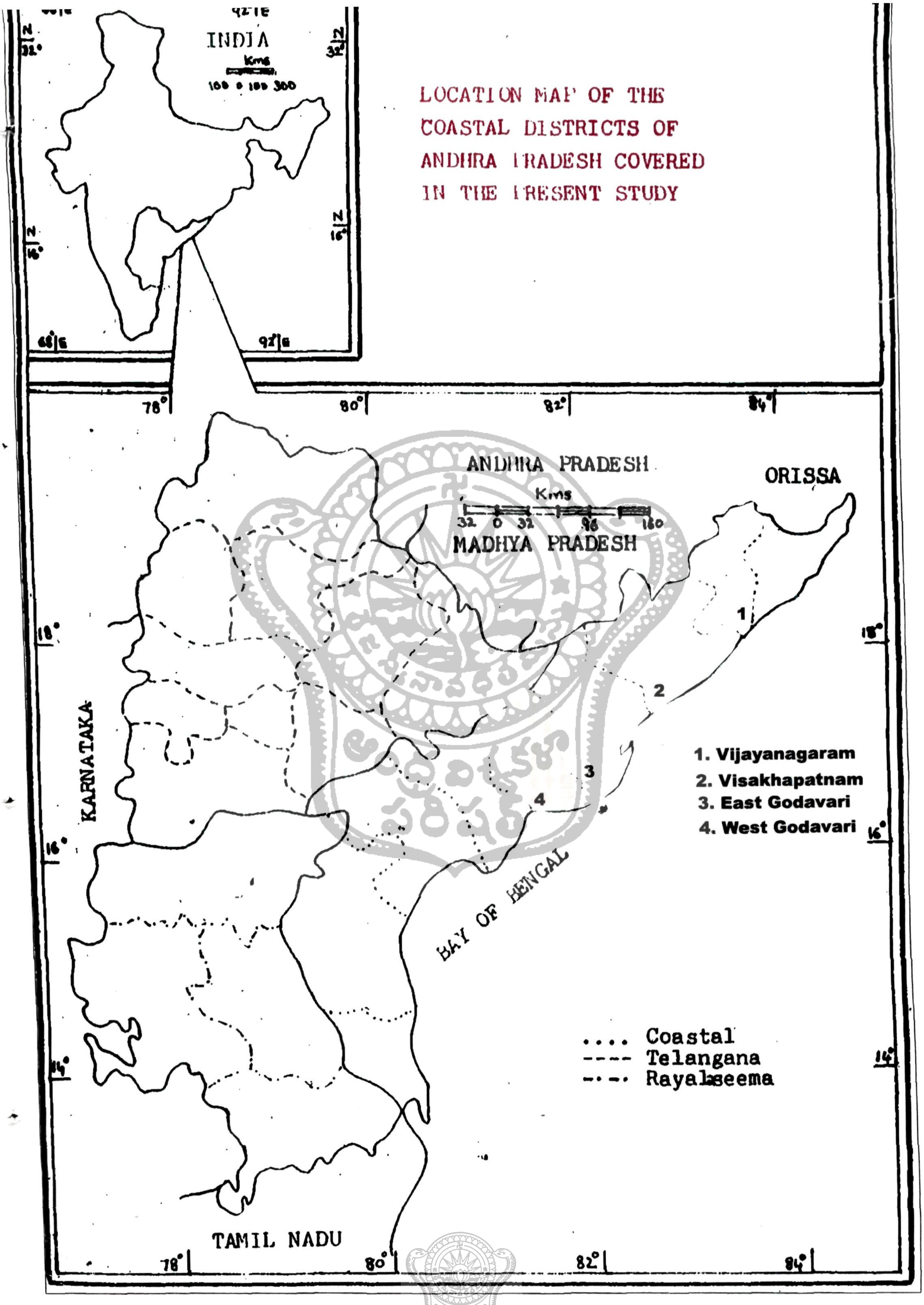
The head quarters of West Godavari is Eluru. It is on the bank of the swamp that surrounds Kolleru Lake.

The Urban and Rural areas chosen from the above-mentioned districts are given below.

URBAN: Visakhapatnam, Vijayanagaram,

Rajahmundry, Bheemavaram.

RURAL: Amanaam,Taallavalasa, Rambelli, Atreyapuram, Kosurinagar, Ryali, Polamuru, Satyavada, Vadluru.



LOCATION MAP OF THE COASTAL DISTRICTS OF ANDHRA PRADESH COVERED IN THE PRESENT STUDY

CHAPTER–3

SCOPE OF THE STUDY

MATERIALS AND METHODS

Scope of the Study:

The objective of the present study is to understand the demo genetic structure of the Kshatriya community, an endogamous population of Andhra Pradesh.

Several populations in Andhra Pradesh were studied in this line but the Kshatriya community has not been touched so far. This community has some unique features. It is small in size, distributed in certain pockets of Andhra Pradesh. Therefore, the four coastal districts of Andhra Pradesh were selected to collect the genetic demographic and related information. Hence it is thought worthwhile to study this population with regard to the consequences of inbreeding, genetic load and selection intensity.

The present study will give an opportunity to understand the patterns, consequences of consanguinity and genetic load. Further, the index of opportunity for natural selection provides an idea to understand the contribution of prenatal mortality and the extent of variation and changes in trends of natural selection.

Materials and Methods:

The areas selected for the present work are from four districts of Andhra Pradesh. Andhra Pradesh is the fifth largest state in India, having an area of over 2,76,754 sq. km. This coastal state, the largest in peninsular India, has 23 districts. The state can be divided into three geographical zones – the Coastal plain, Eastern ghats, the Deccan plain.

Genetic demography data have been collected from four districts (Visakhapatnam, Vijayanagaram, East Godavari and West Godavari) of North – coastal Andhra Pradesh, comprising 820 families from urban and 680 families from rural areas. Detailed pedigree information from each couple was collected. Demographic information was as per the following schedule.

DEPARTMENT OF HUMAN GENETICS
ANDHRA UNIVERTY
VISAKHAPATNAM

Guide: *Prof. P.Veerraju*
Date:

Co Guide: *T.Venkateswar Rao*
Place:

I. *DEMOGRAPHIC AND FAMILY COMPOSITION OF PROPOSITUS*:

Sl.No.		Male	Female
1.	Name		
2.	Surname		
3.	Gothra		
4.	Age		
5.	Native Place		
6.	Migration		
7.	Education		
8.	Occupation		
9.	No. of years of Service		
10.	Total Income		
11.	Marriage Age		
12.	Marriage Type		
13.	Multiple Marriage		
14.	Family Type		
15.	Family Planning		
16.	Smoker or Non Smoker		
17.	Alcoholic or Non Alcoholic		
18.	Colour Blindness		
19.	Genetic Anomalies		

20. Congenital Malformations
21. General Diseases
22 No. of Brother (s) Alive
23. No. of Sisters (s) Alive
24. No. of Brother (s) Dead
25. No. of Sister (s) Dead
26. Age of Father/If dead Age&Cause
27. Age of Mother/If dead Age&Cause
28. Gothra of Father
29. Gothra of Mother
30. Native Place of Father
31. Native Place of Mother
32. Occupation of Father
33. Occupation of Mother
34. Consanguinity of Parents
35. Family Planning of Parents
36. Diseases of Father
37. Diseases of Mother
38.

Pedigree of Male Propositus family. -

II *GYNIC HISTORY OF THE FEMALE:*

Sl.No.		
1.	Menarcheal Age	
2.	Duration of Menstrual Period	
3.	Usual Interval of Menstrual Period	
4.	Menopausal Age	
5.	Hysterectomy	
6.	Cause of Hysterectomy	
7.	Age of First Conception	
8.	Age of Last Conception	
9.	Total No.of Conception	
10.	Total No.of Live Births	
11.	Total No.of Survival Children	
12.	Total No.of Abortions	
13.	Total No.of still Births	
14.	Total No.of Prenatal Deaths (AB+SB=TPND)	
15.	Total No.of Postnatal Deaths (ND+ID+JD=TPND)	
16.	Total No.of Adult Deaths	

Pedigree of Female Propositus family : -

III. *OBSTETRIC INFORMATION OF FEMALE* :

Birth Order	Mother Age at Conception	Mother Age at Birth	Ab/Sb/Lb	Sex	Deliver Type	Alive			Dead		Diseases
						Age	Month	Year	Age	Cause	

Pedigree of Propositus : -

The definitions of various terms used in the present study are as follows:

Fertility:

Fertility is expressed in terms of number of pregnancy terminations and live born offspring per fertile woman. The fertile women are those who conceived at least once in their lifetime at the time of investigation.

Live Birth:

The termination of pregnancy into a viable child.

Mortality:

Mortality is expressed both as the number of deaths per woman and proportion over total pregnancies, Which includes both prenatal and postnatal deaths.

Prenatal Deaths:

It includes all fetal deaths before birth and classified as abortions and still births

Abortions:

The spontaneous or induced termination of pregnancy before the fetus has developed enough to be expected to live if born (up to and including sixth month of gestation).

Stillbirth:

Fetal deaths from seventh month of gestation to before birth

Postnatal Deaths:

It includes all deaths from birth to the reproductive age and classified as neonatal deaths, infant deaths, juvenile deaths and adult deaths

Neonatal Deaths

The death of a live-born infant during the first 28 days after birth The interval from birth to 28 days of age is neonatal period It represents the time of the greater risk to the infant Approximately 6% of all deaths that occur in the first year of life happen during this 4-week period

Neonatal Mortality

The statistic rate of infant death during the first 28 days after live births, expressed as the number of such deaths per 1000 live births in a specific geographic area or institution in a given time is called neonatal mortality Early neonatal death is usually considered to be one that occurs during the first 7 days

Infant Deaths:

The death of a live-born infant after one month and before one year of age

Infant Mortality:

The statistic rate of infant death during the first year live birth, expressed as the number of such births per 1000 live births in a specific geographic area or institution in a given period of time. Neonatal mortality accounts for 70% of infant mortality. Mortality rate among infants is of special significance because it is regarded as one of the most sensitive indices of health conditions of the general population. It is a sensitive measure of health because a baby in its extra uterine life is suddenly exposed to a multitude of new environmental factors and their reactions are reflected in this rate. It is also due to congenital, genetic disabilities or disorders originating in uterine life.

Juvenile Deaths:

Deaths after one year of birth and before reaching their reproductive age.

Adult Deaths:

All the deaths after reproductive age.

Sterility:

Number of Women who never conceived before the onset of menopause.

STATISTICAL METHODS

Arithmetic Mean ($\bar{X}$):

The Arithmetic mean of a group is the simple arithmetic average of the observations. This is calculated by dividing the sum of all the observations by the number of observations.

$$\bar{X} = \frac{\sum X_i}{n}$$

Where,

X_i = Value of the observation 'i' and

n = Total number of observations

Variance(v) and Standard Deviation(σ):

The average of squared deviation from arithmetic mean is called Variance.

$$V = \frac{\sum(X_i-\bar{X})^2}{n}$$

Standard deviation is the square root of the average of the squared deviations of the observations from the arithmetic mean. It is the most important measure of variability.

$$\sigma = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n}}$$

Where,

X_i =Value of the observation .i, and,

$\bar{X}$=Arithmetic average and

n =Total number observations

Standard Error of the Mean:

$$\text{S.E of } \bar{X} = \frac{\sigma}{\sqrt{n}}$$

Standard Error of Standard Deviation:

$$\text{S.E of } \sigma = \frac{\sigma}{\sqrt{2n}}$$

't' Distribution:

The 't' distribution, also known as student's t – distribution, is a sampling distribution derived from the parent normal distribution, introduced by W S Gosset and developed by R A Fisher.

In the present work this test is used to find out whether

the variance of the two groups are the same or not.

$$t = \frac{\left| \bar{X}_1 - \bar{X}_2 \right|}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where

$$S = \sqrt{\frac{n_1\sigma_1^2 + n_2\sigma_2^2}{n_1 + n_2 - 2}}$$

$\bar{x}_1$=Arithmetic average of population/sample 1

$\bar{x}_2$=Arithmetic average of population/sample 2

n_1=Size of population/sample 1

n_2=Size of population/sample 2

σ_1=Standard deviation of population 1

σ_2=Standard deviation of population 2

Index of Opportunity for Natural Selection:

The indices of opportunity for natural selection are calculated as per Crow (1958) and Johnston and Kensinger (1971).The indices are estimated using the reproductive histories of the women who had completed their fertility.

Crow's Index:

$$I = I_m + \frac{I_f}{P_s}$$

Where,

$$I_m = \frac{P_d}{P_s} = \text{Index of selection due to mortality}$$

P_d = Probability to die before reaching the reproductive age

P_s = 1 – P_d = Probability to survive up to reproductive age

$$I_f = \frac{V}{(\bar{X})^2} = \text{Index of selection due to fertility}$$

V = Variance due to fertility

$\bar{X}$ = Mean number of children per woman

Johnston and Kensinger's Index:

The index of total selection is further separated into prenatal and postnatal mortality components by Johnston and Kesinger in 1971.

$$I = I_{me} + \frac{I_{mc}}{P_b} + \frac{I_f}{P_b \times P_s}$$

Where,

$I_{me} = \frac{P_{ed}}{P_b}$ = Index of total selection due to prenatal mortality

P_{ed} = Probability to die before birth

$P_b = 1 - P_{ed}$ = Probability to survive till birth

$I_{mc} = \frac{P_d}{P_s}$ = Index of total selection due to postnatal mortality

P_d = Probability to die before reaching the reproductive age

$P_s = 1 - P_d$ = Probability to survive up to reproductive age

$I_f = \frac{V}{(\bar{X})^2}$ = Index of total selection due to fertility

V = Variance due to fertility

$\bar{X}$ = Mean number of children per woman

Inbreeding Coefficient (F):

It is estimated following the general formula of Wright.

F for Autosomal gene (F_a):

The formula for F_a of a pedigree is

$$F_a = \sum(\tfrac{1}{2})^{n-1}$$

Where,

n = no. of paths from each common ancestor to the child of the consanguineous marriage and back to the common ancestor

$\sum$ = Summation over all common ancestors

Often there is more than one pair of common ancestors in the pedigree of an individual. The effect of multiple consanguinity is additive in the F value with every chain of n generations contributing $(\frac{1}{2})^{n+1}$.

F for Sex-linked gene (F_s):

Consanguineous marriages do not affect the genotype frequencies in sons who have only a single X chromosome. Therefore, there is no meaning to the F_s of a male. The F_s in a female, is calculated as above but only the number of females in a path are counted and any path with two successive males is entirely omitted.

Genetic Load:

Genetic load is estimated according to Morton et al., (1956).

The probability of death due to deleterious alleles present at a given i^{th} locus is the genetic load at the locus L_i. Thus, the probability of survival will be given by

$$P_i = 1 - L_i$$

The probability of survival considering all possible loci as per the assumption that the various genetic causes of death act independently and the probability of surviving the deleterious effects of two loci is equal to the product of the probabilities of surviving the effects of each, is given by

$$P = P_1 P_2 P_3 \ldots . P_n = P_i = \pi(1 - L_i)$$

Where π indicates the product over all loci. Environmental causes of death as per the assumption that genetic causes of death act independently from environmental causes of death is given by P_a, then the over all probability of survival is given by

$$P_s = P_a P$$

Taking logarithms on both sides

$\log P_s = \log P_a + \log P = \log P_a + \sum \log (1 - L_i)$

Where the summation is extended over all loci.

The probability of death L_i, for each locus is small especially if one considers only mutational load. Thus, $\log(1 - L_i)$ can be approximated to $(-L_i)$.

Therefore, $-\log P_s = L_i + X$

Where, $X = (-\log P_a)$ and corresponds to the non-genetic cause of death.

Since at any given locus i, $L_i = a_i + b_i F$.

For many loci, $\sum L_i = \sum a_i + F \sum b_i$.

We can therefore rewrite the overall probability of survival as,

$-\log P_s = X + \sum a_i + F \sum b_i = A + BF$.

Where, $A = X + \sum a_i$ indicates the load, partly due to non-genetic causes 'X' and partly due to genetic causes under random mating itself, $\sum a_i$. B is the inbred load and is taken to provide a measure of lethal equivalents in the population. B/A ratio has been suggested by Morton et al., (1956) as a criterion to differentiate the type of load acting on the population. A high value of this ratio is taken as mutation load where the genes are maintained by mutation selection balance and a low value represents that the genes are maintained by heterotic selection.

Exponential analysis is used to determine inbreeding effects.

If P_i represents the estimated proportion of individuals having an attribute A in the i^{th} subgroup based on consanguinity of marriage and F_i is the inbreeding coefficient for that subgroup, then the functional form used to represent the relationship of P_i to F_i is given by

$$P_i = 1 - e^{-(\alpha + \beta F_i)}$$

The equation can be written as

$$1 - P_i = e^{-(\alpha + \beta F_i)}$$

Taking the natural logarithm (base e) on both sides, we obtain

$$-\ln (1 - P_i) = \alpha + \beta F_i$$

If we now put

$$Z_i = -\ln (1 - P_i)$$

Then the regression of Z_i is exactly linear

$$Z_i = \alpha + \beta F_i$$

Z_i is called the "exponent" and the model fitting as exponential analysis.

Estimating the Parameters α and β:

Let us denote the estimated values of α and β as A and B respectively. In class 'i' let us suppose that there are S_i unaffected out of a total of T_i individuals. If $T_i > 0$ in every class and there are 4 classes (i = 1,2,3,4) the following is the iterative computational method to find the values of A and B (the designed accuracy is set in this case as 0.00001).

$$P_i = \log_e \frac{T_i}{S_i}$$

$$W_i = \frac{T_i \times S_i}{T_i - S_i} \quad (\text{if } S_i = T_i,\ W_i = T_i \times S_i)$$

IT = 1
Increment IT by 1

$A = \sum W_i$
$B = \sum W_i F_i$
$C = \sum W_i (F_i)^2$
$D = \sum W_i P_i$
$E = \sum W_i P_i F_i$

$$SI_{IT} = \frac{(DC - BE)}{(AC - B^2)}$$

$$RI_{IT} = \frac{(AE - BD)}{(AC - B^2)}$$

In the first iterative $RI_1 = 0$

If $| RI_{IT} - RI_{IT-1} | \leq 0.00001$

The coefficients A and B are the values of SI_{IT} and RI_{IT} respectively.

If $| RI_{IT} - RI_{IT-1} | > 0.00001$

Continue for the next iteration

$$SE_I = T_I \times e^{-(SI_{IT} + RI_{IT} \times F_I)}$$

$$W_I = \frac{(T_I \times SE_I)}{(T_I - SE_I)}$$

Go to beginning of increment IT by 1

Testing for goodness of fit (Chi-Square Test):

If SI and RI are the values of A and B respectively at the final iterative above, then,

$$PE_I = e^{-(SI + RI \times FI)}$$

$$W_I = T_I \times PE_I (1 - PE_I)$$

$$PE_I = \frac{S_I}{T_I}$$

$$\bar{T} = \sum T_I$$

$$\bar{P} = \sum W_I PE_I$$

$$\bar{S} = \sum S_I$$

$$\bar{W} = \sum W_I$$

$$PB = \frac{\bar{P}}{\bar{W}}$$

$$SB = \frac{\bar{S}}{\bar{T}}$$

$$\text{Contingency } \chi^2 = \frac{\sum T_i (PR_i - SB)^2}{SB\,(1 - SB)}$$

$$\chi^2 \text{ Total} = \frac{\sum T_i (PR_i - PB)^2}{PE_i\,(1 - PE_i)} \quad \text{with 3 degrees of freedom} \qquad (1)$$

$$\chi^2 \text{ regression} = \sum T_i (PE_i - PB)^2 \quad \text{with 1 degree of freedom} \qquad (2)$$

$$\chi^2 \text{ deviation from regression} = \chi^2 \text{ Total} - \chi^2 \text{ regression}$$
$$= (1) - (2) \text{ with 2 degrees of freedom}$$

CHAPTER–4

RESULTS

CHAPTER–4

RESULTS

Demography represents a fundamental basis for human population genetics. The demographic datum is the basic element of work for the population geneticist (Freire Maia, 1974). Marriage, fertility, migration, mortality, morbidity are important demographic parameters. An understanding of these factors would be of immense value in any demographic study. Fertility and mortality are the prime factors controlling the growth of populations, indirectly influencing the economic development of a country. A significant decline in the rate of population growth requires quick acceptance of the family planning programmes by the public.

The importance of the different parameters included in the present study is explained in chapter 1 and the details of the data collected from different areas are given in chapter 3.Results of the present study are explained in the chapter 4. Available comparative data from other caste population of Andhra Pradesh for the present work is included in this chapter.

Demography

Age at Menarche:

Menarcheal age is an important parameter in demographic studies. It is influenced by genetic factors and non-genetic factors such as nutritional, climatic, socio-economic factors etc.

The frequency distribution of the Kshatriya women, the present study population, according to age at menarche, is given in the table 4.1. The range of distribution of menarcheal age among the Kshatriya women is between 11 and 17 years. Early menarche is observed in the urban area at 11th year (2.07%) and 12th year (8.9%). In rural the area 1.18% girls attained menarche at 11th year and 4.71% at 12th year. In the pooled data 1.67% of the girls attained menarche at 11th year and 7% at 12th year.

Late menarche is more in rural area, (19.26% at 15th year, 7.5% at 16th year and 1.76% at 17th year) than in the urban area, (16.71% at 15th year 4.39 at 16th year and 0.25 at 17th year).

The combined data of rural and urban areas showed 17.87%, 5.8% and 0.93% at ages 15,16, and 17 respectively. Most of the girls in both the areas attained menarche at age 13 and 14 years with more or less the same frequencies.

The means and standard deviations of menarcheal age are given in table 4.2. The difference between the means of urban and rural areas is statistically significant ($t=4.2942; P<0.05$).

Comparison of present study with other studies from Andhra Pradesh is given in the table 4.3. The mean menarcheal age ranges from 13.01% in Chakali (Babu and Naidu , 1989) to 14.76% in Telaga (Chakravarthi and Renuka , 1970). The mean menarcheal age in the present study (13.86 in the pooled data of urban and rural areas) falls within the range observed in other caste populations of Andhra Pradesh.

Table. 4.1

Frequency distribution of Kshatriya women by age at Menarche

Area	11	12	13	14	15	16	17	Total
No Urban	17	73	224	331	187	36	02	820
%	(2.07)	(8.90)	(27.32)	(40.36)	(16.71)	(4.39)	(0.25)	(100)
No Rural	08	32	183	263	131	51	12	680
%	(1.18)	(4.71)	(26.91)	(38.68)	(19.26)	(7.5)	(1.76)	(100)
No U+R	25	105	407	594	268	87	14	1500
%	(1.67)	(7.00)	(27.13)	(39.6)	(17.87)	(5.8)	(0.93)	(100)

Table. 4.2

Means and Standard deviations of Menarcheal ages in Kshatriya women

Area	TNW	Mean	S.D.
Urban	820	13.75	1.0848
Rural	680	13.99	1.1021
U+R	1500	13.86	1.0848

$t=4.2942; p<0.05$

Table. 4.3

Mean Menarcheal age in Castes of Andhra Pradesh

Population	No	Mean±S.E	Source
Kshatriya	1500	13.86±0.028	Present Study
Arya Vysya	301	13.56±0.060	Lakshmi,1994
Brahmin	389	14.63±0.400	Chakravarthi & Renuka,1970
Chakali	104	13.01±0.080	Babu & Naidu,1989
Ediga	104	14.18±0.180	Bhaskar et.al.,1986
KalingaVysya	287	13.04±0.060	Lakshmi,1994
Kapu	300	13.70±0.570	Chakravarthi & Renuka,1970
Kamma	147	14.50±0.320	Chakravarthi & Renuka,1970
Kshatriya	40	14.45±0 300	Chakravarthi & Renuka,1970
Kummari	63	13.33±0.110	Babu & Naidu,1989
Madiga	92	13.21±0.110	Babu & Naidu,1989
Mangali	112	13.13±0.080	Babu & Naidu,1989
Reddy	30	13.86±0.250	Chakravarthi & Renuka,1970
Relli	428	13.07±0.050	Ramesh,1992
Telaga	121	14.76±0.060	Chakravarthi & Renuka,1970
Trivarnika	258	13.50±0.070	Lakshmi,1994
Vysya	16	14.60±0.520	Chakravarthi & Renuka,1970
Vishwa Brahmans	516	13.10±0.0886	Subba Rao.1996

Age at Menopause

Menopause is cessation of menstruation naturally It is the sign of the end of the reproductive period and is of considerable interest for diverse reasons Evolutionary biologists, demographers and biometricians have an interest in describing and predicting fertility trends in women because a substantial proportion of variance of age at natural menopause is attributable to genetic factors According to Susan (1998) the age at menopause is more concordant among monozygotic twins than between dizygotic twins

In the present study 162 women in the urban and 193 women in the rural areas attained menopause Those women who underwent hysterectomy are not included in this group

Distribution of Kshatriya women according to age at menopause is given in table 4 4 Most of the women attained menopause between 45 and 49 years in both rural and urban areas (45 08% and 52 46% respectively),next highest percentage is between 40and 44 years followed by 50and54 years in both rural and urban areas While none of the urban women attained menopause before 40 years and after 54 years, in the rural areas,7 78% women attained menopause before 40 years and 1 55% women attained menopause after 54 years

The means and standard deviations of age at menopause are given in table 4 5 The mean age at menopause among the urban women is higher (46 38) than that of rural women (45 75)

However, difference between two groups is not significant (t=1.4017,p>0.05)

The comparative data on age at menopause in different caste populations of Andhra Pradesh are given in table 4.6. The mean values of present study are more or less similar to other castes of Andhra Pradesh.

Table 4.4

Frequency Distribution of Kshatriya Women by age at Menopause

Area	30-34		35-39		40-44		45-49		50-54		55-59	
	No	%	No	%	No	%	No	%	No	%	No	%
Urban (162)	---	---	----	-----	41	25.31	85	52.46	31	19.14	----	----
Rural (193)	02	1.04	13	6.74	55	28.49	87	45.08	33	17.19	03	1.55
U+R (355)	02	0.56	18	5.07	96	27.04	172	48.45	64	18.03	03	0.85

Table 4.5

Means and Standard Deviations of Menopausal Age

Area	N	Mean	SD
Urban	162	46.3827	3.7175
Rural	193	45.7564	4.5249
Urban+Rural	355	46.0423	4.1873

$t=1.4017;p>0.05$

Table 4.6

Mean Menopausal Age In Castes of Andhra Pradesh

Population	N	Mean ± S.E.	Source
Kshatriya	355	46.04±0.2222	Present Study
Arya Vysya	40	45.53±0.7100	Lakshmi,1994
Chakali	33	44.45±0.4300	Babu&Naidu,1989
Ediga	32	43.94±0.4700	Babu&Naidu,1989
Kalinga Vysya	23	44.11±0.9000	Lakshmi,1994
Kummari	18	45.89±0.2700	Babu&Naidu,1989
Madiga	27	46.07±0.2400	Babu&Naidu,1989
Mangali	37	45.95±0.1400	Babu&Naidu,1989
Relli	112	45.57±0.2700	Ramesh,1992
Trivarnika	50	45.34±0.6200	Lakshmi,1994
VishwaBrahmin	--	46.18±0.3400	Subba Rao,1996

Age at Marriage:

The age at marriage being a socio – cultural variable has an important role in demographic studies, because early marriage is associated with longer fertility period.

According to Siva Ram et al., (1995), the mean age at marriage of female was 18.6 in the rural and 19.6 in urban areas of North Arcot Ambedker district of Tamilnadu of South India. The proportion of females married before attaining the legal age of marriage 18 years was higher among rural community (36.8%) than in the urban community (28.9%). According to Rao (1977) nearly 30% of all marriages in the urban and 50% of marriage in rural areas were consanguineous.

The frequency distribution of Kshatriya women according to age at marriage in the present study is given in table 4.7. Most of the Kshatriya women were married between 15 and 19 years in both urban (75.12%) and rural (77.50%) areas followed by 20 and 24 years (21.10% in the urban women and 10.59% in the rural women). In the pooled data 76.20% of the women were married between 15.and 19 years, followed by 20 and 24 years (16.33%).

The means and standard deviations of age at marriage in the urban and rural areas are presented in table 4.8. The mean age at marriage in the urban area is 17.96 while in the rural area it is 17.00. The mean age difference observed in between the urban and rural women with regard to age at marriage is statistically significant ($t=7.6218; p<0.05$).

Table 4.7

Frequency distribution of Kshatriya women by age at marriage

	Urban		Rural		Urban+Rural	
	No	%	No	%	NO	%
10-14	26	3.17	78	11.47	104	6.93
15-19	616	75.12	527	77.50	1143	76.20
20-24	173	21.10	72	10.59	245	16.33
25-29	05	0.006	3	0.44	08	0.53

Table 4.8

Means and Standard Deviations of Marriage ages in Kshatriya Women

Area	TNW	Mean	SD
Urban	820	17.9573	2.4001
Rural	680	17.0000	2.4405
U+R	1500	17.5233	2.4649

t=7.6218;P<0.05.

Fertility and Mortality

Age at First Conception:

The length of the birth interval between marriage and first conception is one of the strongest and most persistent factors affecting the fertility in a population The longer intervals are usually associated with lower fertility

The frequency distribution of Kshatriya women by age at first conception is given in table 4 9 There are 786 urban women and 657 rural women ever conceived in the present study In urban women the age at first conception ranges between 14 and 29,while in rural areas it is 13 and 34 In both the areas most of the women conceived for the first time between 15 and 19 years(61 19% in the urban and 73 21% in the rural areas),followed by 20-24 years(37 15% in the urban and 23 59% in the rural areas) In the pooled data 66 67% of women conceived for the first time between 15 and 19 years, while 30 98% conceived between 20 and 24 years

The means and standard deviations for age at first conception are given in the table 4 10 The Mean age at first conception in urban area is 18 91 while it is 18 23 in rural area In the pooled data the mean age at first conception is 18 59 years The difference between the urban and rural areas with respect to age at first conception is statistically significant (t=4 9832 p< 0 05)

Table 4.9

Distribution of Kshatriya Women by age at First Conception

Area	10-14		15-19		20-24		25-29		30-34	
	No	%	No	%	No	%	No	%	No	%
Urban (786)	06	0 76	481	61 19	292	37 15	07	0 9	---	--
Rural (657)	13	1 98	481	73 21	155	23 59	05	0 76	03	0 46
U+R (1443)	19	1 32	962	66 67	447	30 98	12	0 83	03	0 21

Table 4.10

Mean age at First Conception along with Standard Deviation

Area	TNW	Mean	SD
Urban	786	18 9084	2 5936
Rural	687	18.2252	2.5846
U+R	1443	18 5974	2.6118

t=4.9832:p< 0.05.

Age at Last Conception

Age at last conception is another important parameter as it is considered to be the end of the fertility by either naturally or voluntarily.

The frequency distribution of women by age at last conception in Kshatriya population is shown in the table 4.11.An overall range of 15-39 years, in the age at last conception is observed in both the urban and rural women. In the urban area most of the women had their last conception between 20 and 24 years(69.27%)followed by 25-29 years(16.25%) and 15-19 years(10.65%). In the rural area also most of the women had their last conception between 20 and 24 years(62.24%).However this was followed by 15-19 years(16.96%) and 25-29 years (14.08%). In the pooled data the frequencies are in the order 20-24 years > 25-29 years > 15-19 years (66.13%,15.26%,and13.52% respectively).

The means and standard deviations of age at last conception in Kshatriya women are given in table 4.12.The mean age at last conception is 22.69 in urban and 22.58 in rural women. In the pooled data the mean age at last conception is 22.64. The difference between urban and rural women with respect to age at last conception is not statistically significant ($t=0.5493;p>0.05$).

Table 4.11

Distribution of Kshatriya Women by age at Last Conception

Area	15-19		20-24		25-29		30-34		35-39	
	No	%	No	%	No	%	No	%	No	%
Urban	80	10.65	521	69.27	122	16.25	22	2.93	06	0.80
Rural	106	16.96	389	62.24	88	14.08	35	5.6	07	1.12
U+R	186	13.52	910	66.13	210	15.26	57	4.14	13	0.95

Table 4.12

Mean age at Last Conception Along with Standard Deviation

Area	TNW	Mean	SD
Urban	751	22.6911	3.3124
Rural	625	22.5840	3.9419
U+R	1376	22.6432	3.6124

$t=0.54932$:$p> 0.05$

Total Conceptions

The frequency distribution of total number of conceptions among Kshatriya women is shown in the table 4 13 The maximum number of conceptions is 10 in the urban women and 12 in the rural women

Most of the urban women have 2 conceptions (49 15%) followed by 3 conceptions (20 98%) The frequency of women never conceived is 4 15% In the rural area also most of the women have 2 conceptions (44 12%) followed by 3 conceptions (23 09%) The frequency of never conceived women is 3 38% In the pooled data also the same trend is observed women with 2 conceptions are 46 87% followed by 3 conceptions (21 93%) and 3 8% women never conceived

The means and standard deviations for the total number of conceptions are given in the table 4 14 The difference between the urban and rural women with regard to total number of conceptions is not statistically significant (t = 1 498 p > 0 05)

Table 4.13

Frequency Distribution of Kshatriya Women by number of Conceptions

Cp	Urban		Rural		Urban+Rural	
	No of women	%	No of women	%	No of women	%
0	34	4.15	23	3.38	57	3.8
1	78	9.51	66	9.71	144	9.60
2	403	49.15	300	44.12	703	46.87
3	172	20.98	157	23.09	329	21.93
4	67	8.17	62	9.12	129	8.60
5	29	3.54	27	3.97	56	3.73
6	13	1.59	18	2.65	31	2.07
7	09	1.09	09	1.32	18	1.20
8	10	1.22	10	1.47	20	1.33
9	04	0.48	03	0.44	07	0.47
10	01	0.12	03	0.44	04	0.27
11	----	----	----	----	----	----
12	----	----	02	0.29	02	0.13
Total	820	100	680	100	1500	100

Table 4.14

Means and Standard Deviations in Total Conceptions among Kshatriya Women

Area	TNW	TNCps	Mean	SD
Urban	820	2080	2.5366	1.4533
Rural	680	1852	2.7235	1.6548
U+R	1500	3932	2.6213	1.5507

$t=1.4980; p>0.05$.

Abortions:

The frequency distribution of abortions among the Kshatriya women is given in table 4.15. Among the urban women 89.15% suffered no abortions while 9.27% women suffered one abortion and 0.24% suffered the maximum number of 3 abortions. The same trend is observed in rural women also. No abortions are observed among 88.82% of rural women and single abortion was suffered by 9.71%. A maximum number of 4 abortions were suffered by 0.15%. In the pooled data no abortions were suffered by 89% and single abortions among 9.47% of women. A maximum number of 4 abortions was suffered by 0.06% of the women. The means and standard deviations for abortions among Kshatriya women are given in table 4.16. The difference between the urban and rural women is not statistically significant (t=0.2692;p>0.05).

Table 4.15

Frequency Distribution of Kshatriya Women by Number of Abortions in Total Marriages

Abortions	Urban		Rural		U+R	
	No	%	No	%	No	%
0	731	89.15	604	88.82	1335	89.00
1	076	09.27	066	09.71	0142	09.47
2	011	01.34	007	01.03	0018	01.20
3	002	00.24	002	00.29	0004	00.27
4	----	----	001	00.15	0001	00.06
Total	820	100	680	100	1500	100

Table 4.16

Means and Standard Deviations of Abortions among Kshatriya Women

Areas	TNW	TNAbs	Mean	SD
Urban	820	104	0.1268	0.3900
Rural	680	90	0.1324	0.4132
U+R	1500	194	0.1293	0.4007

t=0.2692;p>0.05.

Still Births:

The frequency distribution of still births among Kshatriya women is given in table 4.17. Single still birth was suffered by 5.24% of the women, and a maximum number of 2 still births by 0.24% women in the urban area. The rest of the women (94.51%) suffered no still births. In the rural area single still birth was suffered by 4.12% of the women followed by two still births (0.29%). A maximum number of 4 still births were suffered by 0.15% of the rural women.

In the pooled data the frequency of women suffered single still birth 4.73% followed by two still births (0.27%).

The means and standard deviations of the still births are given in table 4.18. The difference between the urban and rural women is not statistically significant (t = 1.0476 and p > 0.05).

Table 4.17

Frequency Distribution of Kshatriya Women by Number of Still births

	Urban		Rural		U+R	
	No	**%**	**No**	**%**	**No**	**%**
0	775	94.51	649	95.44	1424	94.00
1	043	05.24	028	04.12	071	04.73
2	002	00.24	002	00.29	004	00.27
3	----	----	----	----	----	---
4	----	----	001	00.15	0001	00.07
Total	820	100	680	100	1500	100

Table 4.18

Means and Standard Deviations of Still Births among Kshatriya Women

Area	TNW	TNSbs	Mean	SD
Urban	820	47	0.0573	0.2427
Rural	680	36	0.0529	0.2715
U+R	1500	83	0.0553	0.2561

t=1.0476;p>0.05.

Prenatal Deaths:

The frequency distribution of prenatal deaths among Kshatriya women is given in table 4.19. A maximum number of 3 prenatal deaths are observed in the urban area and 4 prenatal deaths in the rural area. Most of the women in both urban and rural areas suffered single prenatal deaths (14.51% in the urban and 13.82% in the rural area).

Means and standard deviations of prenatal deaths are given in table 4.20. The difference between the urban and rural areas is not significant (t=0.0502;p>0.05).

Table 4.19

Frequency distribution of Kshatriya
Women by Number of Prenatal deaths

	Urban		**Rural**		**U+R**	
No. of PNDs	**No**	**%**	**No**	**%**	**No**	**%**
0	686	83.66	573	84.27	1259	83.93
1	119	14.51	94	13.82	213	14.2
2	13	1.59	09	1.32	22	1.47
3	02	0.24	02	0.29	04	0.27
4	-	-	02	0.29	02	0.13
Total	820	-	680	-	1500	

Table 4.20

Means and Standard Deviations of Prenatal deaths among Kshatriya Women

Area	TNW	TNPNDs	Mean	SD
Urban	820	151	0.1841	0.4434
Rural	680	126	0.1853	0.4830
U+R	1500	277	0.1847	0.4603

$t=0.0502; p > 0.05$.

Live Births:

The frequency distribution of Kshatriya women by total number of live births is shown in Table 4.21.

A maximum number of 10 live births in urban women and 12 live births in rural women are observed. Most of the women in the urban and rural areas have 2 live births (54.39% and 48.24% respectively) followed by 3 live births (17.07% and 19.85% respectively). In the pooled data frequency of women with 2 live births and 3 live births are 51.6% and 18.33% respectively.

Mean number of live births along with standard deviation are presented in table 4.22.The mean number of live births is high among the rural women (2.54) than among the urban women (2.36).

The difference between the urban and rural women is significant ($t = 2~4578$, $p < 0~05$)

The difference may be attributed to several factors Family planning programmes which is more popular in the urban areas than in the rural areas is an important among them Further, the urban women are more educated and aware of the advantages of small families Most of their husbands are also educated and employed Medical facilities in urban area are relatively better than in the rural area, which reduced the mortality rates It is well Known that reduced mortality rates lead to a lower mean number of live births while high mortality rates lead to a high mean number of live births to compensate the infant and juvenile deaths The neonatal, infantile and juvenile death in the present study, described elsewhere, are high in rural area than in urban area also and lend support to above said point

Table 4.21

Frequency Distribution of Kshatriya Women by Number of Live Births

	Urban		Rural		U+R	
	No	**%**	**No**	**%**	**No**	**%**
0	34	4.15	23	3.38	57	3.8
1	90	10.98	81	11.98	171	11.4
2	446	54.39	328	48.24	774	51.6
3	140	17.07	135	19.85	275	18.33
4	60	7.32	54	7.94	114	7.6
5	27	3.29	25	3.68	52	3.47
6	09	1.09	14	2.06	23	1.53
7	08	0.98	08	1.18	16	1.07
8	05	0.61	08	1.18	13	0.87
9	-	-	02	0.29	02	0.13
10	01	0.12	-	-	01	0.07
11	-	-	-	-	-	-
12	-	-	02	0.29	02	0.13
	820		680		1500	

Table 4.22

Means and Standard Deviations Of Live births among Kshatriya Women

Area	TNW	TNLbs	Mean	SD
Urban	820	1937	2.3622	1.2733
Rural	680	1729	2.5426	1.514
U+R	1500	3666	2.444	1.3905

$t=2.4578; p<0.05$.

Pre reproductive Deaths:

Details of neonatal deaths, infantile deaths and juvenile deaths are given in table 4.23. Their means and standard deviations are given in table 4.24. Neonatal, infantile, and juvenile deaths are more among the rural women (55.32%, 56.90%, 59.57% respectively) than among the urban women (44.68%, 43.10%, 40.43% respectively).

Mean values for neonatal, juvenile and infant deaths in the rural area are 0.076, 0.041 and 0.049 respectively, while; they are 0.051, 0.023 and 0.031 respectively in the urban area.

Considering the three types of deaths independently, the differences between the rural and urban areas are close to significance but not significant. However, when all the three types of deaths are pooled together, the difference between the rural and urban is significant ($t=3.2229; p<0.05$).

Table 4.23

Distribution of Pre reproductive Deaths among Kshatriya Women

Area	TNW	TNNDs		TNIDs		TNJDs		TNPRDs	
		No	%	No	%	No	%	No	%
Urban	820	42	44.68	25	43.10	19	40.43	86	43.22
Rural	680	52	55.32	33	56.90	28	59.57	113	56.78
U+R	1500	94	100.00	58	100.00	47	100.00	199	100.00

Table 4.24

Mean Number of Pre reproductive Deaths along with Standard Deviations among Kshatriya Women

Area	TNWs	TNNDs		TNIDs		TNJDs		TNPRDs	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Urban	820	0.051	0.231	0.031	0.179	0.023	0.158	0.105	0.322
Rural	680	0.076	0.292	0.049	0.228	0.041	0.227	0.166	0.413
U+R	1500	0.063	0.261	0.039	0.203	0.031	0.193	0.133	0.368
t-value		**1.8741**		**1.7143**		**1.8182**		**3.2229**	
P -value		**>0.05**		**>0.05**		**>0.05**		**<0.05**	

Surviving Children:

Details of surviving children among the Kshatriya women are given in table 4.25. It is observed that 4.27% of the women in the urban area and 3.68% in the rural area did not have any survival children. Majority of the women in both urban and rural areas had two children (55.85% and 49.41% respectively) followed by three children (16.34% in urban women and 18.68% in rural women). A maximum number of eight (8) surviving children was observed among 0.12% of the women in urban area. In the rural area a maximum of eleven (11) surviving children was observed among 0.15% of the women. The pooled data shows that 4% of the women did not have surviving children, and 52.93% of women had two children followed by 17.40% of women with three children.

The mean number of surviving children along with standard deviation among the urban and rural women in table 4.26. The rural women had a mean number of 2.5588 surviving children while the urban women had 2.2451. The mean number of surviving children in the pooled data is 2.2696.

The difference between the urban and rural women with respect to surviving children is statistically significant ($t=4.1715; p<0.05$).

Table 4.25

Frequency distribution of Kshatriya Women by number of Surviving Children

Urban			Rural		U+R	
	No	%	No	%	No	%
0	35	4.27	25	3.68	60	4.00
1	101	12.32	100	14.71	201	13.4
2	458	55.85	336	49.41	794	52.93
3	134	16.34	127	18.68	261	17.40
4	57	6.95	48	7.05	105	7.00
5	20	2.44	22	3.24	42	2.80
6	12	1.46	13	1.91	25	1.65
7	02	0.24	05	0.73	07	0.47
8	01	0.12	01	0.15	02	0.13
9	-	-	02	0.29	02	0.13
10			-	-		
11	-	-	01	0.15	01	0.075
	820		680		1500	

Table 4.26

Means and Standard Deviations of Surviving Children among Kshatriya Women

Area	TNW	TNSch	Mean	SD
Urban	820	1841	2.2451	1.1108
Rural	680	1605	2.5588	1.7709
U+R	1500	3446	2.2696	1.1849

$t=4.1715; p<0.05$.

Sterility:

According to Jackquard and Wand (1976) sterility effects the variability of fertility and provides scope for the action of natural selection via fertility differential. Individuals who survive and do not contribute to the next generation by reproduction are genetically dead for the population. The frequency distribution of sterile women among Kshatriya population is given in table 4.27.The frequency of sterile women is 1.46% in urban area, 1.03% in rural area and 1.27% in the pooled data.

Table 4.27

Distribution of Sterile Women among Kshatriya population

Area	Total Number Of Women	Number Of Sterile Women	%
Urban	820	12	1.46
Rural	680	07	1.03
Total	1500	19	1.27

Inbreeding:

One of the parameters entering into the general theory of the populations structure is the inbreeding rate (Wright, 1922). Inbreeding rates vary widely in human population. The highest coefficient of inbreeding was observed in India, Japan, Brazil and Israel. The lowest one is in the United States (Friere-Maia, 1967). No homogeneity exists within a country, a province or even a township. Schull et.al.,(1968) were probably the first to bring out clearly that socio-cultural factors such as education, occupation, income, religion and age at marriage may confound the effects of inbreeding. The effects of inbreeding are most pronounced on diseases and defects, which determined rare recessive deleterious genes. Rarer the gene more pronounced is the effect. Such data has been reported from western countries and Japan on conditions like Albinism, Tay Sachs disease, Ichthyosis Congenita and Xeroderma-pigmentosm (Stern,1960). Significant association was found between consanguinity and neural tube defects in Bombay and in Alexandria (Stevenson et.al.,1966).

In India, the State of Andhra Pradesh provides a good opportunity for the study of inbreeding effects in a population that still prefers consanguineous marriages. The present study population, Kshatriya community is an endogamous group, spread over densely in north coastal Andhra Pradesh has been chosen for the work. Five types of marriages are taken into consideration in the present work by taking pedigree to determine the degree of relationship between the couple. They are

a) Uncle-niece (U-N)

b) First cousins (FC)

c) First cousins once removed (FCOR)

d) Second cousins (SC)

e) Affinal (A), spouses who were unrelated

Results

Frequency distribution of different types of marriages among the Kshatriyas is given in table 4 28 Consanguineous marriages are slightly higher in the urban area (21 46%) than in the rural area (20 59%) Considering different types of consanguineous marriages Uncle- niece marriages are more in the urban area while First cousin marriages are more in the rural area Marriages between the First cousins once removed are almost the same in both the areas while second cousin marriages are more in urban area

Inbreeding coefficients ('F') for autosomal and sex linked alleles among Kshatriya population are given in table 4 29 The 'F' value for autosomal alleles is almost the same in the urban and rural areas Inbreeding coefficient for sex linked alleles (Fs) is slightly higher in the rural area (0 0189) than in the urban area (0 0185)

Frequency of consanguineous marriages in different endogamous caste populations of Andhra Pradesh is given in table 4 30 The lowest frequency (13 61%) was reported by Srikumari (1985) among the Brahmins while the highest (47 46%) was reported by

Govinda Reddy (1985) among Desuri Kapu. The populations studied by different workers at different periods are interesting. Among the Brahmins Sanghvi (1966) reported 25.61% consanguineous marriages while Srikumari (1985) reported 13.61% Among the Jalaris Veerraju (1973) reported 47.10% consanguinity while Srikumari (1985) reported 39.16%. There is a decrease of consanguineous marriages in these two populations over a period of time.

Inbreeding coefficients for autosomal and sex linked alleles in different endogamous caste populations of Andhra Pradesh are given in table 4.31. The Kshatriyas of the present study fall within the range of the values from different populations, studied so far.

Table 4.28

Frequency Distribution of marriage Types among Kshatriya Women

Marriage Type	Urban (820)		Rural (680)		U+R (1500)	
	N0	%	No	%	No	%
A	644	78.52	539	79.26	1183	78.86
CM	176	21.46	141	20.59	317	21.13
U-N	58	07.07	42	06.18	100	06.67
FC	71	08.66	76	11.18	147	09.80
MBD	53	06.46	56	08.24	109	07.27
FSD	18	02.29	20	02.94	38	02.53
FCOR	123	02.81	14	02.06	37	02.47
SC	24	02.93	09	01.32	33	02.20
MBD	19	02.32	05	0.740	24	01.60
FSD	05	0.610	04	0.580	09	0.600

Table 4.29

Inbreeding Coefficients for Autosomal (F_a) and Sex linked(F_s) alleles in the Present Study

Area	F_a	F_s
Urban	0.01558	0.0185
Rural	0.01555	0.0189
U+R	0.01557	0.0186

Table 4.30

Comparative study of marriage types among Different caste Populations of Andhra Pradesh

Population	Number	A	CM	Source
Kshatriya	1500	78.86	21.13	Present Study
Arya Vysya	301	79.40	20.60	Lakshmi,1994
Brahmins-1	82	74.39	25.61	Sanghvi,1966
Brahmins-2	632	86.39	13.61	SriKumari,1985
Chakali	104	68.27	31.73	Babu & Naidu,1989
Desuri kapu	927	52.54	47.46	Govinda Reddy,1985
Devanga	866	51.74	48.26	Govinda Reddy,1985
Harijans	1185	60.68	39.32	Sanghvi,1966b
Jalari	102	52.9	47.10	Veerraju,1973
Jalari	495	60.84	39.16	SriKumari etal,1985
KalingaVysya	287	73.87	26.13	Lakshmi,1994
Kapu-1	740	69.95	30.05	Chakravarthi,1968
Kapu-2	616	72.60	27.40	Reid,1971
Kammas	60	56.07	43.03	Veerraju,1973
Kummari	63	84.13	15.87	Babu & Naidu,1989
Mala	367	70.03	29.97	Reddy,1986
Mala	731	59.37	40.63	Govinda Reddy,1985
Madiga	92	67.39	32.61	Babu & Naidu,1989
Mangali	112	61.61	38.39	Babu & Naidu,1989
Reddy	119	61.45	38.55	Reddy,1986
Relli	428	59.81	40.19	Ramesh,1992
Sali	82	73.20	26.80	Veerraju,1973
Trivarnika	258	68.60	31.40	Lakshmi,1994
Vadde	2078	67.56	32.44	Reddy,1992
VishwaBrahmins	516	65.12	34.88	SubbaRao,1996
Urban(Vizag)	7056	67.72	32.28	RajaniKumari,1980
Rural(Vizag)	1553	67.29	32.71	RajaniKumari,1980

Table 4.31

Comparative Study of Inbreeding Coefficients Among different caste Populations of Andhra Pradesh

Population	Number	F_a	F_s	Source
Kshatriya	1500	0.0156	0.0186	Present Study
Arya Vysya	301	0.0183	0.0253	Lakshmi,1994
Brahmins-1	82	0.0190	0.0320	Sanghvi,1966
Brahmins-2	632	0.0104	0.0159	SriKumari,1985
Harijans	1185	0.0290	0.0460	Sanghvi,1966
KalingaVysya	287	0.0233	0.2920	Lakshmi,1994
Kapu-1	740	0.0250	0.0340	Chakravarthi,1968
Kapu-2	616	0.0170	0.0240	Reid,1971
Mala(Rural)	88	0.0276	0.0547	Rao & Murthy,1986
Madiga	168	0.0247	0.0363	Rao & Murthy,1986
Pattusali	265	0.0296	---------	Reddy & Rao,1978
Reddy(Rural)	321	0.0137	0.0293	Rao & Murthy,1986
Relli	428	0.0310	0.0288	Ramesh,1992
Sali	82	0.0200	0.0310	Veerraju,1973
Trivarnika	258	0.0248	0.0292	Lakshmi,1994
Vadde	2078	0.0185	--------	Reddy,1992
VishwaBrahmins	516	0.0409	0.0335	SubbaRao,1996
Vysyas(urban)	163	0.0222	0.0389	Rao & Murthy,1986
Vysyas(Rural)	81	0.0102	0.0174	Rao & Murthy,1986
Urban(Vizag)	7056	0.0293	0.0371	RajaniKumari,1980
Rural(Vizag)	1553	0.0303	0.0370	RajaniKumari,1980

Mortality and Fertility

Prenatal deaths:

Details of total conceptions and prenatal mortality based on marriage type among the Kshatriyas in the urban and rural areas as well as pooled data are given in table 4.32, 4.33, 4.34 respectively. In the urban area, both abortions and still births are more among the affinal marriages (5.23% and 2.30% respectively) than in the consanguineous marriages (4.23% and 2.11% respectively) . On the other hand , both abortions and still births in the rural area are more in consanguineous marriages (5.62% and 2.44% respectively) than in the affinal marriages (4.64% and 1.80% respectively).

Availability of medical facilities and awareness of health care during pregnancy might have contributed for this trend. Availability of medical facilities tempt the couples to go for medical termination of unwanted conceptions while this is not possible in rural area. This might have led to higher percentage of abortions in the affinal marriages in urban area.

In the pooled data, the frequencies of abortions, stillbirths as well as total prenatal deaths are almost the same in affinal and consanguineous marriages.

Table 4.32

Distribution of Prenatal Deaths among Kshatriya Women according to Marriage Type-URBAN

Marriage Type	TNW	TNCps	TNAbs		TNSbs		TNPNDs	
			No	%	No	%	No	%
A	644	1607	84	5 23	37	2 30	121	7 53
CM	176	473	20	4 23	10	2 11	30	6 34
UN	58	164	06	3 66	09	5 49	15	9 15
FC	71	200	12	6 00	01	0 50	13	6 50
FCOR	23	50	01	2 00	---	----	01	2 00
SC	24	59	01	1 69	---	----	01	1 69
Total	820	2080	104	5 00	47	2 26	151	7 26

Table 4.33

Distribution of Prenatal Deaths among Kshatriya Women according to Marriage Type-RURAL

Marriage Type	TNW	TNCps	TNAbs		TNSbs		TNPNDs	
			No	%	No	%	No	%
A	539	1443	67	4 64	26	1 80	93	6 44
CM	141	409	23	5 62	10	2 44	33	8 07
UN	42	135	12	8 89	02	1 48	14	10 37
FC	76	225	09	4 00	08	3 56	17	7 56
FCOR	14	27	02	7 41	----	-----	02	7 40
SC	09	22	----	-----	----	-----	-----	------
Total	680	1852	90	4 86	36	1 94	126	6 80

Table 4.34

Distribution of Prenatal Deaths among Kshatriya Women according to Marriage Type-URBAN+RURAL

Marriage Type	TNW	TNCps	TNAbs		TNSbs		TNPNDs	
			No	%	No	%	No	%
A	1183	3050	151	4.95	63	2.07	214	7.02
CM	317	882	43	4.88	20	2.27	63	7.14
UN	100	299	18	6.02	11	3.68	29	9.69
FC	147	425	21	7.02	09	2.12	30	7.06
FCOR	37	77	03	3.89	---	-----	03	3.89
SC	33	81	01	1.24	---	-----	01	1.23
Total	1500	3932	194	4.93	83	2.11	277	7.04

Mean values of total conceptions, abortions, stillbirths and total prenatal deaths along with standard deviations among the consanguineous and non consanguineous couples in rural and urban areas are presented in table 4.35. The difference between the affinal and consanguineous marriages with regard to the means for total conceptions, abortions, stillbirths and total prenatal deaths in urban as well as rural areas are not significant. In the pooled data also they are not significant.

Table 4.35

Means and Standard Deviations of Prenatal Deaths Among Kshatriya Women

		Cps		Abs		Sbs		PNDs	
Marriage Type	**Number**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
URBAN									
A	644	2.4953	1.4770	0.1304	0.3921	0.0575	0.2394	0.1879	0.4428
CM	176	2.6875	1.5481	0.1136	0.3822	0.0568	0.2548	0.1704	0.4453
Total	820	2.5366	1.4553	0.1268	0.0096	0.0573	0.2427	0.1841	0.4434
t-value		**1.5140**		**0.5064**		**0.0339**		**0.4661**	
p-value		**>0.05**		**>0.05**		**>0.05**		**>0.05**	
RURAL									
A	539	2.6772	1.6023	0.1243	0.4056	0.0482	0.2748	0.1725	0.4698
CM	141	2.9007	1.8308	0.1631	0.4397	0.0709	0.2567	0.2341	0.4858
Total	680	2.7235	1.6548	0.1324	0.4132	0.0529	0.2715	0.1853	0.4830
t-value		**1.4302**		**0.9935**		**0.8850**		**1.3764**	
p-value		**>0.05**		**>0.05**		**>0.05**		**>0.05**	
U+R									
A	1183	2.5782	1.9366	0.1276	0.3984	0.0583	0.3090	0.1809	0.4591
CM	317	2.7823	1.6831	0.1356	0.4095	0.0637	0.2557	0.1924	0.4649
Total	1500	2.6213	1.5507	0.0129	0.4007	0.0553	0.2561	0.1847	0.4603
t-value		**1.7111**		**0.3156**		**0.2860**		**0.3950**	
p-value		**>0.05**		**>0.05**		**>0.05**		**>0.05**	

Details of total prenatal deaths in different caste populations based on marriage type are given in table 4.36. The incidence of total prenatal deaths is higher among the consanguineous marriages in all the populations except the Vadde (Reddy 1992). Among the Vadde the values are 0.77% in the affinal and 0.33% in the consanguineous matings. This may be mainly because of under reporting of abortions and stillbirths by the couples.

Table 4.36

Prenatal deaths among different Caste Populations of Andhra Pradesh

Population	Affinal			Consanguineous			Source
	TNCps	TNPNDs		TNCps	TNPNDs		
	No	No	%	No	No	%	
Kshatriya	3050	214	07.02	882	63	07.14	Present Study
Arya Vysya	677	73	10.78	237	46	19.41	Lakshmi.1994
Brahmins	2274	312	13.77	404	52	12.87	SriKumari.1985
Desuri kapu	1529	----	0.460	2010	----	07.36	Govinda Reddy.1985
Devanga	1637	----	3.60	2175	---	10.07	Govinda Reddy,1985
KalingaVysya	718	80	11.14	291	34	11.68	Lakshmi.1994
Mala	1424	----	3.59	1504	-----	8.07	Govinda Reddy.1985
Trivarnika	462	58	12.55	234	30	12.82	Lakshmi.1994
Vadde	5469	42	0.77	2666	09	0.330	Reddy.1992
Kamsali	620	40	6.45	446	53	11.88	SubbaRao,1996
Vadrangi	584	54	9.25	341	33	9.67	SubbaRao.1996

Live births:

Distribution of live births among the Kshatriyas in the urban, rural and pooled data with respect to marriage type is given in the tables 4.37,4.38and 4.39 respectively.

The frequency of live births in the urban area is more among the consanguineous matings (94.50%) than in the affinal matings (92 72%). On the other hand, in the rural area their frequency is more among the affinal matings (93.62%) than in the consanguineous matings (92.42%). In the pooled data they are almost the same in the both the groups. The lower frequency of live births among the affinal matings in urban area is the consequence of more prenatal deaths among them.

Table 4.37

Distribution of Live Births among

Kshatriya Caste Women URBAN

Marriage Type	TNW	TNCps	TNLbs	%
A	644	1607	1490	92.72
CM	176	473	447	94.50
U-N	58	164	149	90.85
FC	71	200	190	95.00
FCOR	23	50	49	98.00
SC	24	59	59	100.00
Total	820	2080	1939	93.13

Table 4.38

Distribution of Live Births among Kshatriya Women RURAL

Marriage Type	TNW	TNCPs	TNLbs	%
A	539	1443	1351	93.62
CM	141	409	378	92.42
U-N	42	135	121	89.63
FC	76	225	210	93.33
FCOR	14	27	25	92.59
SC	09	22	22	100.00
Total	680	1852	1729	93.36

Table 4.39

Distribution of Live Births among Kshatriya Women URBAN+RURAL

Marriage Type	TNW	TNCPs	TNLbs	%
A	1183	3050	2841	93.15
CM	317	882	825	93.54
U-N	100	299	270	90.30
FC	147	425	400	94.12
FCOR	37	77	74	96.10
SC	33	87	81	100.00
Total	1500	3932	3666	93.23

Mean number of live births along with standard deviations among the urban, rural and pooled data according to marriage type are given in table 4.40. The difference between the means of affinal and consanguineous matings in the urban and pooled data are significant(t=2.0935 and 2.2897 respectively) while it is not significant in the rural area(t=1.2194)

Table 4.40

Means and Standard Deviations of Live births Among Kshatriya Women

		TNCps		TNLbs	
Marriage Type	**Number**	**Mean**	**SD**	**Mean**	**SD**
URBAN					
A	644	2.4953	1.4770	2.3137	1.2302
CM	176	2.6875	1.5481	2.5398	1.4056
Total	820	2.5366	1.4553	2.3622	1.2733
t-value		**1.5140**		**2.0935**	
p-value		**>0.05**		**<0.05**	
RURAL					
A	539	2.6772	1.6023	2.5065	1.4559
CM	141	2.9007	1.8308	2.6809	1.7107
Total	680	2.7235	1.6548	2.5426	1.5140
t-value		**1.4302**		**1.2194**	
p-value		**>0.05**		**>0.05**	
U+R					
A	1183	2.5782	1.9366	2.4015	1.3413
CM	317	2.7823	1.6831	2.6025	1.5503
Total	1500	2.6213	1.5507	2.4440	1.3905
t-value		**1.7111**		**2.2897**	
p-value		**>0.05**		**<0.05**	

Percentage frequencies of total live births in different populations of Andhra Pradesh are given in table 4.41.The frequency of live births is almost the same in the Kshatriya, Kalinga Vysya, Trivarnika, Brahmin and Vadrangi. However, total live births are less in consanguineous marriages among the Arya Vysya and Kamsali.

Table 4.41

Total number of Live Births in different Caste Populations of Andhra Pradesh

Population	**Marriage Type**				**Source**
	Affinal		**Consanguineous**		
	No	**%**	**No**	**%**	
Kshatriya	2841	93.15	825	93.54	Present Study
Arya Vysya	607	89.66	191	80.59	Lakshmi,1994
Kalinga Vysya	639	89.00	259	89.00	Lakshmi,1994
Trivarnika	408	88.31	205	87.61	Lakshmi,1994
Brahmin	1962	86.27	352	87.13	Srikumari,1985
Kamsali	580	93.55	393	88.12	SubbaRao.1996
Vadrangi	530	90.75	308	90.32	SubbaRao.1996

Total Pre reproductive Deaths:

Distribution of neonatal, infantile and juvenile deaths as well as total pre reproductive deaths in both consanguineous and non consanguineous marriages are presented in tables 4.42, 4.43 and 4.44 respectively for the urban and rural areas and for pooled data.

Neonatal deaths are more in the consanguineous matings (2.91%) in urban area than in non consanguineous matings (1.95%), while they are more in affinal marriages in the rural area (3.11%) than in consanguineous marriages (2.65%). A reverse trend is observed for the infantile deaths. Infantile deaths are more in affinal marriages (1.41%) than in consanguineous marriages (0.89%) in urban area. In the rural area they are more in consanguineous (2.12%) than in affinal marriages (1.85%). As for the juvenile deaths, they are more in consanguineous marriages in both urban and rural areas (2.01% and 2.12% respectively) than in the affinal marriages (0.67% and 1.48% respectively).

Total pre reproductive deaths are more in consanguineous marriages in both urban and rural areas (5.81% and 6.88% respectively) than in affinal (4.03% and 6.44% respectively).

Considering the urban and rural area differences, total pre reproductive deaths are more in rural area in both types of marriages than in urban area. While excess of pre reproductive deaths in both areas in consanguineous marriages can be attributed to recessive lethal or sub lethal factor, excess of total pre reproductive deaths in rural area than in urban in both mating types may be because of lack of enough medical facilities and child care.

Means along with standard deviations of pre reproductive deaths in different types of marriages in the urban and rural areas as well as pooled data are given in table 4.45. The difference between the means of consanguineous and non consanguineous marriages is significant only for total pre reproductive deaths in urban area (t=1.996) while it is not significant in the rural area. The difference for neonatal deaths and infantile deaths between consanguineous and non consanguineous matings in both urban and rural areas is not significant. Considering pooled data for the difference for total pre natal deaths is significant while the difference for all other values is not significant.

Total pre reproductive deaths in different caste populations of Andhra Pradesh is shown in table 4.46. Their frequency is higher in consanguineous marriages in all the populations.

Table 4.42

Distribution of Pre reproductive Deaths among Kshatriya Women URBAN

Marriage Type	TNW	TNLbs	TNNDs		TNIDs		TNJDs		TNPRDs	
			No	%	No	%	No	%	No	%
A	644	1490	29	1.95	21	1.41	10	0.67	60	4.03
CM	176	447	13	2.91	04	0.89	09	2.01	26	5.81
U-N	58	149	02	1.34	---	-----	04	2.68	06	4.02
FC	71	190	08	4.21	03	1.58	05	2.63	16	8.42
FCOR	23	49	----	-----	---	-----	---	-----	---	-----
SC	24	59	03	5.08	01	1.69	---	-----	04	6.77
Total	820	1937	42	2.17	25	1.29	19	0.98	86	4.44

Table 4.43

Distribution of Pre reproductive Deaths among Kshatriya Women RURAL

Marriage Type	TNW	TNLbs	TNNDs		TNIDs		TNJDs		TNPRDs	
			No	%	No	%	No	%	No	%
A	539	1351	42	3.11	25	1.85	20	1.48	87	6.44
CM	141	378	10	2.65	08	2.12	08	2.12	26	6.88
U-N	42	121	05	4.13	03	2.48	03	2.48	11	9.09
FC	76	210	04	1.90	04	1.90	05	2.38	13	6.19
FCOR	14	25	01	4.0	01	4.0	---	----	02	8.00
SC	09	22	---	----	---	----	---	----	----	----
Total	680	1729	52	3.01	33	1.91	28	1.62	113	6.54

Table 4.44

Distribution of Pre-reproductive Deaths among Kshatriya Caste Women URBAN+RURAL

Marriage Type	TNW	TNLbs	TNNDs		TNIds		TNJDs		TNPRDs	
			No	%	No	%	No	%	No	%
A	1183	2841	71	2.49	46	1.62	30	1.06	147	5.17
CM	317	825	23	2.79	12	1.45	17	2.06	52	6.30
U-N	100	270	07	2.59	03	1.11	07	2.59	17	6.29
FC	147	400	12	3.00	07	1.75	10	2.5	29	7.25
FCOR	37	74	01	1.35	01	1.35	---	----	02	2.70
SC	33	81	03	3.70	01	1.23	---	----	04	4.93
Total	1500	3666	94	2.56	58	1.58	47	1.28	199	5.42

Table 4.45

Means and Standard Deviations of Pre reproductive Deaths Among Kshatriya Women

Marriage Type	Number	Lbs		NNDs		IDs		JDs		PRDs	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
URBAN											
A	644	2.3137	1.2302	0.0451	0.2149	0.0326	0.1776	0.0155	0.1237	0.0932	0.2959
CM	176	2.5398	1.4056	0.0739	0.2825	0.0227	0.0335	0.0511	0.2447	0.1477	0.4000
Total	820	2.3622	1.2733	0.0512	0.2313	0.0305	0.1789	0.0232	0.1584	0.1049	0.3220
t-value		**2.0935**		**1.4656**		**0.7352**		**2.6557**		**1.9960**	
p-values		**<0.05**		**>0.05**		**>0.05**		**<0.05**		**<0.05**	
RURAL											
A	539	2.5065	1.4559	0.0779	0.2943	0.0464	0.2189	0.0371	0.1985	0.1614	0.3971
CM	141	2.6809	1.7107	0.0709	0.2830	0.0567	0.2604	0.0567	0.3098	0.1844	0.4704
Total	680	2.5426	1.5140	0.0765	0.2921	0.0485	0.2283	0.0412	0.2265	0.1662	0.4134
t-value		**1.2194**		**0.2534**		**0.4774**		**0.9168**		**0.5883**	
p-values		**>0.05**		**>0.05**		**>0.05**		**>0.05**		**>0.05**	
U+R											
A	1183	2.4015	1.3413	0.0601	0.2546	0.0389	0.1977	0.2540	0.1625	0.1243	0.3474
CM	317	2.6025	1.5503	0.0712	0.2802	0.0379	0.2216	0.0536	0.2757	0.1641	0.4331
Total	1500	2.4440	1.3905	0.0627	0.2609	0.0387	0.2027	0.0313	0.1926	0.1327	0.3676
t-value		**2.2897**		**0.6745**		**0.0779**		**2.3221**		**1.7140**	
p-value		**<0.05**		**>0.05**		**>0.05**		**<0.05**		**>0.05**	

Table 4.46

Prereproductive Deaths in different Caste Populations of Andhra Pradesh

Population	Marriage Types				Source
	Affinal		Consanguineous		
	No	%	No	%	
Kshatriya	147	5.17	52	6.30	Present Study
Arya Vysya	55	9.06	19	9.95	Lakshmi,1994
Desuri kapu	----	8.31	----	37.76	GovindaReddy,1985
Devanga	----	18.57	----	39.59	GovindaReddy,1985
Kalinga Vysya	70	10.95	40	15.44	Lakshmi,1994
Mala	----	15.89	----	30.79	GovindaReddy,1985
Trivarnika	41	10.05	30	15.09	Lakshmi,1994

Surviving children:

Frequency distribution of total surviving children in consanguineous and non consanguineous marriages in urban and rural areas are shown in table 4.47 and 4.48 respectively. Their distribution in pooled data is shown table 4.49. It is evident from these tables that the frequency of total surviving children is more in affinal marriages than in consanguineous marriages in urban (95.77% and 92.62% respectively) and rural (93.12% and 91.79%respectively) areas. The pooled data has also shown the same trend.

Mean number of surviving children along with standard deviation among the consanguineous and non consanguineous marriages in the urban and rural areas as well as in pooled data is given table 4.50. The differences between consanguineous and non consanguineous marriages are not significant in the urban and rural areas. However, in the pooled data , the difference is close to significance (t=1.7147).

Table 4.47

Distribution of Surviving Children Among Kshatriya Women Urban

Marriage Type	TNW	TNLbs	TNSch	%
A	644	1490	1427	95.77
CM	176	447	414	92.62
U-N	58	149	140	93.96
FC	71	190	173	91.05
FCOR	23	49	47	95.92
SC	24	59	54	91.53
Total	820	1937	1841	95.04

Table 4.48

Distribution of Surviving Children

Among Kshatriya Women Rural

Marriage Type	TNW	TNLbs	TNSch	%
A	539	1351	1258	93.12
CM	141	378	347	91.79
U-N	42	121	109	90.08
FC	76	210	193	91.91
FCOR	14	25	23	92.00
SC	09	22	22	100.00
Total	680	1729	1605	92.83

Table 4.49

Distribution of Surviving children

among Kshatriya Women Urban+Rural

Marriage Type	TNW	TNLbs	TNSch	%
A	1183	2841	2684	94.47
CM	317	825	762	92.36
U-N	100	270	250	92.59
FC	147	400	366	91.50
FCOR	37	74	70	94.59
SC	33	81	76	93.83
Total	1500	3666	3446	93.99

Table 4.50

Means and Standard Deviations of Surviving children among Kshatriya Women

		Lbs		Schs	
Marriage Type	**Number**	**Mean**	**SD**	**Mean**	**SD**
URBAN					
A	644	2.3137	1.2302	2.2158	1.2213
CM	176	2.5398	1.4056	2.3523	1.1335
Total	820	2.3622	1.2733	2.2451	1.1108
t-value		**2.0935**		**1.3339**	
p-value		**<0.05**		**>0.05**	
RURAL					
A	539	2.5065	1.4559	2.3339	1.2733
CM	141	2.6809	1.7107	2.4609	1.4612
Total	680	2.5426	1.5140	2.3603	1.3154
t-value		**1.2194**		**1.0215**	
p-value		**>0.05**		**>0.05**	
U+R					
A	1183	2.4015	1.3413	2.2696	1.1849
CM	317	2.6025	1.5503	2.4006	1.2907
Total	1500	2.4440	1.3905	2.2973	1.2093
t-value		**2.2897**		**1.7147**	
p-value		**<0.05**		**>0.05**	

Genetic Load:

The concept of genetic load has been discussed extensively by population geneticists (Crow,1958: Li,1963 and Sanghvi,1963) . The genetic load is a quantity designed to measure the loss of fitness in a population due to selection. Crow (1958) defined genetic load to be the relative decrease in the average fitness of a population, with respect to the fitness it would have if all individuals in the population had the genotype that has maximum fitness. Muller (1950) in a famous paper introduced the concept of load, which was first applied to genes maintained in equilibrium by mutation – selection balance; he called the loss of zygotes due to deleterious genes as the mutational load. The genetic load due to over dominance loci is called the segregational load. A classification of genetic load by Freire-Maia (1975,1976) into 17 types and some aspects of them are discussed with special emphasis to the problem in man giving a general view. Genes which are deleterious when homozygous can be grouped under two primary classes (Cavalli Sforza and Bodmer, 1971): 1) Genes that are not deleterious, or are only moderately deleterious when heterozygous. Then the fitness of the AA and Aa are almost the same and the genotype (aa) where the deleterious gene is in homozygous state is at a disadvantage. Under such conditions the gene frequency of the deleterious gene 'a' will be kept very low by the balance between mutation and selection. 2) The second category of 'over dominant genes' consist of the genes for which the heterozygote is the fittest genotype, and is therefore more fit than either homozygote. Such genes become polymorphic, so that either allele (a or A) can attain a relatively high frequency. They are mostly referred as over dominant.

Haldane defined (1937) fitness of a genotype as the average number of progeny left by an individual of the genotype and explained that average fitness of a species will almost be close to unity, as otherwise the population would increase rapidly.

In the progeny of consanguineous matings for both the type of genes, homozygotes will occur with increased frequency and thus the fitness of the population will decrease with inbreeding.

On the basis of Haldane and Muller's contributions the concept of genetic load was utilized by Morton et al., (1956) who developed a method of analyzing the genetic load that was aimed at distinguishing the relative importance of the two classes of genes, deleterious recessives and over dominants, in determining the genetic load. The estimation of load due to combined effects of many loci is considered on the assumption that the corresponding fitness is entirely accounted for by some fraction of, or perhaps all of the pre reproductive mortality. Further the various genetic causes of death are assumed to act independently and that the probability of surviving the deleterious effects of two loci is equal to the product of the probabilities of surviving the effects of each of them.

In estimating the total damage another assumption is that genetic and environmental causes of death act independently. These two assumptions are critical to the development of load theory In a randomly mating population where the inbreeding coefficient F = 0, the expressed genetic damage, together with the environmental damage is represented by estimate 'A' Estimate 'B' on the other hand is measure for the hidden genetic damage that could manifest itself only with complete homozygosity (F=1) The total genetic damage is the sum 'B' and genetic component of 'A' and hence, lies between 'B' and 'B+A'

Morton et al , (1956) distinguished between the total damage due to disadvantageous mutations present in the human genome and expressed damage Both are called as lethal equivalents A lethal equivalent is a group of mutations that, distributed among various individuals, causes one death, on the average for genetic reasons The total damage per gamete was defined as the average number of lethal equivalent in the zygote, if doubling of all chromosomes of the gametes formed the zygote The expressed damage per gamet is the average number of lethal equivalent of this gamete that would be manifested if combined in the zygote with another gamete according to the mating systems actually prevailing in the population

It is difficult to classify a death as genetic or nongenetic There may be little doubt with deaths among people with serious genetic diseases While counting deaths we cannot however, determine which single genes caused death except in rare circumstances Thus the effects of deleterious alleles at all loci must be accumulated (Cavalli Sforza,1971)

Results:

By definition, genetic variation, with respect to fitness, results in a genetic load. To measure the genetic load, mortality data has been extensively used (Morton et.a.l,1956; Schull and Neel 1972; Fraser and Mayo 1974). 'A' and 'B' estimates and the inbreeding effects of reproductive wastage are calculated according to Smith (1967).

Details of regression analysis of inbreeding effects considering abortions and total prenatal deaths are given in tables 4.51 and 4.52 respectively. The values of 'A' are more or less the same in urban and rural areas considering abortions and stillbirths. However, 'B' values varied between the urban and rural areas both for abortions and prenatal deaths. It is high for abortions in urban area (0.1045) than in rural area (0.0569). However, a reverse trend is observed for total prenatal deaths. The 'B' values in the rural area are high (0.2357) than in the urban area (0.0643).

Details of regression analysis of inbreeding effects for total pre reproductive deaths are given in table 4.53. The value of 'A' is high in rural area (0.0697) than in the urban area (0.0455). However, 'B' value is high in urban area (0.3311) than in rural area (0.2441). The lower 'A' values for abortions and total prenatal deaths as well as total pre reproductive deaths in the urban area could be because of better medical facilities available in urban area. The 'B' values are high in urban area for abortions and total pre reproductive deaths. These could be attributed to high frequency of consanguineous marriages in urban area.

An attempt is made to compare the present study with other populations of Andhra Pradesh and the data on prenatal deaths is presented in table 4.54. In general the 'B' values among the Kshatriya are low compared to several populations of Andhra Pradesh. It could be low since many of the deaths in consanguineous families due to infectious diseases are now low, perhaps due to better health care and for which genetic susceptibility in the Kshatriyas is less serious (Morton et.al.,1956). It is further supported by lower 'A' values.

Estimate 'A' has been decreasing with increase in medical care but within it, the proportion of deaths whose cause is strictly genetic has been increasing (Cavalli-Sforza and Bodmer, 1971). Morton et al., (1956), Vogel and Motulsky (1982) cautiously admit that sociological concomitants of consanguineous marriages (urban - rural differences, etc) may be confounded with genetic effects; the importance of comparable study on population under primitive or rigorous conditions, while they still exist, has been stressed in such studies by affording comparison with those on with modernized populations, but also provide a measure of selection under modern conditions. Kshatriyas being relatively, economically better off than several populations form a good unit for comparison.

The genetic load ('B/A' ratio) indicates that the average gamete carries a number of deleterious genes, if distributed in a single individual and made homozygous, that would kill 2.5826 individuals before birth (based on total prenatal deaths) and 4.0852 individuals before reproductive age (based on total pre reproductive deaths).

The total genetic damage is expressed by summation of all deleterious genes and hence lies between 'B' and 'A+B'. Considering total prenatal deaths, a lethal equivalent between 0.1547 to 0.6546 per gamete or 0.3094 to 1.3092 per zygote in the Kshatriyas is obtained. In general the observed genetic load and lethal equivalents in the Kshatriya population are low when compared with some other studies like Japanese, Brazilians (Schull and Neel,1972; Fraser and Mayo,1974) and also South Indian Keralites (Kumar et.al., 1967). The results of this study support the hypothesis that continued practice of inbreeding for several generations have resulted in the gradual elimination of deleterious genes by segregation (Sanghvi, 1966;Rao and Inbaraj,1979 and 1980).

Table 4.51

Regression Analysis of Inbreeding Effect in Abortions

Area	A	B	B/A	χ^2-regression	χ^2-deviation	χ^2-total
Urban	0.0459	0.1045	2.2767	0.0152	1.8086	1.8216
Rural	0.0445	0.0569	1.2787	0.0047	2.8966	2.9013
U+R	0.0441	0.0149	0.3379	0.0007	1.3825	1.3832

Table 4.52

Regression Analysis of Inbreeding Effect in Prenatal deaths

Area	A	B	B/A	χ^2-regression	χ^2-deviation	χ^2-total
Urban	0.0611	0.0643	1.0524	0.0005	0.6803	0.6808
Rural	0.0639	0.2357	3.6886	0.0581	5.4625	5.5206
U+R	0.0599	0.1547	2.5826	0.0588	1.4943	1.5531

Table 4.53

Regression Analysis of Inbreeding Effect in Pre reproductive deaths

Area	A	B	B/A	χ^2-regression	χ^2-deviation	χ^2-total
Urban	0.0455	0.3311	7.2769	0.0769	3.7685	3.8454
Rural	0.0697	0.2441	3.5022	0.0730	2.3652	2.4382
U+R	0.0575	0.2349	4.0852	0.0145	0.9021	0.9166

Table 4.54

Regression analysis of inbreeding effect In different Populations of Andhra Pradesh

Population	A	B	B/A	Source
Kshatriya	0.0599	0.1547	2.5826	Present Study
Arya Vysya	0.1074	1.2548	11.6859	Lakshmi,1994
Brahmins	0.1496	0.0085	0.0570	SriKumari,1985
Jalari	0.2149	0.4563	2.1230	SriKumari,etal,1985
Kalinga Vysya	0.1214	-0.2912	-2.3983	Lakshmi,1994
Madiga	0.4920	-0.8730	-1.7740	Murthy & Rao,1996
Mala	0.4600	0.0620	0.1348	Murthy & Rao,1996
Reddy	0.2560	1.8690	7.3008	Murthy & Rao,1996
Trivarnika	0.1240	0.1125	0.9069	Lakshmi,1994
Vadde	0.0070	-0.0400	-5.7000	Reddy,1992
VishwaBrahmins	1.7506	-0.8908	-0.5088	SubbaRao,1996
Vysya(Rural)	0.2990	2.3750	7.9431	Murthy & Rao,1996
Vysya (Urban)	0.1810	3.4000	18.7845	Murthy & Rao,1996
Urban (Vizag)	0.1425	0.2390	1.6900	Rajanikumari & Rao,1985
Rural (Vizag)	0.2035	0.6650	3.2700	Rajanikumari & Rao,1985

Index of Opportunity for Selection:

The rate of evolution depends on the available amount of genetic variation in fitness. In human populations the fitness of individuals can be estimated from their number of successful offspring (Jacquard,1974). If there is no genetic variation in fitness there can be no differential selection and hence, in general no significant evolutionary change in the genetic content of a population. According to Fisher's (1930) "Fundamental Theorem Of Natural Selection", the rate of increase of fitness of organism at any time is equal to its genetic variance in fitness at that time.

There are two methods for the calculation of Index of opportunity for natural selection. These are,

CROW'S INDEX:

Based on Fisher's fundamental theorem, Crow (1958) has suggested an index of total selection, 'I'. The index of total selection is $I = V/W^2$, where 'V' is the variance in the number of offspring and 'W' the mean number of offspring. This index measures the maximum change in selectivity, which the population mortality and fertility characteristics could bring forth. In other words, it is a measure of the rate of the evolution of the population under these simplified assumptions, namely that all differences in fitness are completely genetically determined. A real rate of evolution would be much lower, since only a fraction of the differences in fitness are completely genetically determined. A real rate of evolution would be much lower, since only a fraction of the difference in fitness would have a genetic basis. Thus 'I' may be considered as an index of 'Opportunity' for selection. It represents the rate of increase of fitness that could obtain if each offspring had a fitness equal to the mean of the fitness of the parents.

Crow's index can be broken down into two components. These are

-index associated with mortality differences (I_m)

-index associated with fertility differences (I_f)

Crow's index takes into account only live births and postnatal mortality before reproductive age.

JOHNSTON AND KENSINGER'S INDEX:

In contrast to Crow, Johnston and Kensinger (1971) modified the index of opportunity for selection taking into account all pregnancies, prenatal and postnatal mortality (before reproductive age).

Differences in fertility and mortality levels in various groups in a population are of great significance to understand the structure of a population. Recent demographic trends show that many industrialized countries have almost completed the demographic transition through three typical stages (Teitelbaum,1975).

1.Equilibrium of population size achieved by higher death and birth rates, 2.Declining mortality with fertility remaining at various higher levels and consequent population explosion.

3.Birth rate gradually declining towards equilibrium with the now, lower death rates,

The total index is not proportional to the mean number of offspring; it actually increases as the mean number of offspring decreases. Mortality contributes a small fraction to the total index in highly developed industrial societies. The major opportunity for selection in such societies is clearly through differential fertility and this is greatly influenced by birth control practice and modern medical care, both of which undoubtedly tend to reduce the variance in fertility.

The conditions of highly developed industrial societies are certainly quite radically different from those that must have prevailed during most of the time the human species has been evolving, in fact, until almost one hundred or two hundred years ago. For most of this time, mortality, largely due to infectious diseases, must have been a major selective agent.

A fuller understanding of the causes of a selective difference requires a comprehensive specification of the total pattern of reproductivity. The use of Crow's index of opportunity for selection provides only a crude break down of the causes of selection into fertility and mortality components. Many factors, such as age at marriage, the stability of the marriage, the length of the post – partum, sterile period, as well as the mortality, need to be taken into account in a more complete description of the total reproductive history (Cavalli Sforza and Bodmer, 1971).

Selection intensities among the Kshatriyas are studied considering the women who attained menopause and their fertility performance. In the present study 193 women in the rural area and 162 women in the urban area (total 355 women) attained menopause. The number of live births among these women along with the mean and variance is shown in table 4.55. In the rural area the women have a maximum number of twelve live births while in the urban area one women has a maximum of ten live births. Five women in the rural area and eight in the urban area have no live births. Mean number of live births is almost the same in both rural and urban areas (3.64 and 3.56 respectively). However, there is difference in the variance. It is more in the rural area (4.2816) than in the urban area (3.4059).

Statistical constants with regard to the fertility performance of the women who attained menopause are given in table 4.56.

Crow's index of opportunity for total selection and its components are given in table 4.57. It is clear from this table that the proportion of fertility components (76.45% in the urban and 76.42% in the rural areas) is very high in the Kshatriyas.

Opportunity for selection based on fecundity characteristics (Johnston and Kensinger,1971) is presented in table 4.58.Total selection is higher than the Crow's Index for both urban and rural area and it is slightly higher in the rural area (0.5818) than in the urban areas (0.5002). However, the percent of fertility differentials contribution to the measure of total selection is decreased considerably than in Crow's index. The contribution of fertility component is more in rural area (66.33%) than in the urban area (60.54%).

In general, the increased fertility differentials suggest that, when reproductive mortality is reduced, fertility might because a major factor in the operation of natural selection as is evident in some industrially developed populations of U.S.A further, the birth control and modern medical care tend to reduce the variance in fertility (Cavalli-Sforza and Bodmer,1971).

Table 4.59 shows the Crow's index of opportunity for selection in some Indian and foreign populations. The opportunity for selection varies from 0.3100 in Jalari (Rajanikumari, 1985) to 1.668 in Mala (Murthy and Rao,1986).

It is low in the Kshatriyas of the present study compared to several other populations. It is also almost in line with several recently studied populations of Andhra Pradesh. Table4.60 shows the index of Johnston and Kensinger in some Andhra populations. It is clear that in all the populations, there is an increase of this index compared to Crow's index. The I_{me} component is more in Vishwa Brahmins, Brahmins and Vysyas than the other populations. This may be due to better reporting of fertility performance losses from these populations, owing to various ceremonial celebrations, recordings (such as Horoscopes) associated with conceptions, gestation period and birth.

Table 4.55

DISTRIBUTION OF PROGENY AMONG THE WOMEN WHO COMPLETED FERTILITY

No of Children	Rural	Urban	Rural + Urban
0	05	08	13
1	09	04	13
2	52	38	90
3	44	36	80
4	30	32	62
5	20	22	42
6	14	09	23
7	08	08	16
8	07	04	11
9	02	-	02
10	-	01	01
11	-	-	-
12	02	-	02
Total	193	162	355
Mean	3.6425	3.5679	3.6085
Variance	4.2816	3.4059	3 8833

Table 4.56

Fertility Performance among Menopausal Women of Kshatriya Caste

		Urban(162)		Rural(193)		U+R(355)
	No.	Mean±S.E	No.	Mean±S.E	No.	Mean±S.E
Conceptions	636	3.9259±0.1665	757	3.9223±0.1609	1393	3.9239±0.1158
Abortions	32	0.1975±0.0369	34	0.1762±0.0302	66	0.1859±0.0235
Stillbirths	28	0.1728±0.031	20	0.1037±0.0283	48	0.1352±0.0401
Prenatal deaths	60	0.3704±0.0435	54	0.2798±0.0398	114	0.2648±0.0263
Live births	578	3.5679±0.141	703	3.6425±0.1489	1281	3.6085±0.1045
Neonatal deaths	19	0.1173±0.0253	34	0.1762±0.0311	53	0.1493±0.0205
Infantile deaths	16	0.0988±0.025	19	0.0984±0.0249	35	0.0986±0.0177
Juvenile deaths	10	0.0617±0.0208	17	0.0881±0.0251	27	0.0761±0.0166
Pre reproductive deaths	45	0.2778±0.0373	70	0.9363±0.0423	115	0.3239±0.0287
Adult deaths	09	0.0556±0.02	09	0.0466±0.0032	18	0.0507±0.0177
Surviving children	524	3.2346±0.1218	624	3.2332±0.1272	1148	3.2338±0.0887

Table 4.57

Crow's Index of Opportunity for Total Selection in the Present Study Population

Population	I	I_m	I_f/P_s	% I_f/P_s
URBAN	0.3588	0.0845	0.2743	76.45
RURAL	0.4690	0.1106	0.3584	76.42
U+R	0.4263	0.0987	0.3276	76.85

Table 4.58

Johnston and Kensinger's Index of Opportunity for Total Selection in the Present Study Population

Population	I	I_{me}	I_{mc}	$I_f/p_b \times p_s$	% $I_f/P_{s} \cdot P_b$
URBAN	0.5002	0.1041	0.0845	0.3028	60.54
RURAL	0.5818	0.0768	0.1106	0.3859	66.33
U+R	0.5538	0.0890	0.0985	0.3566	64.39

Table 4.59

Crow's Indices of Opportunity for Natural Selection in castes of Andhra Pradesh

Population	No of Women	I_m	I_f	I	Source
Kshatriya	355	0.0987	0.2982	0.4263	Present study
Arya Vysya	183	0.1064	0.3385	0.4809	Lakshmi,1994
Brahmin	450	0.1270	0.1800	0.3300	Rajanikumari et al.,1985
Jalari	197	0.1880	0.1030	0.3100	Rajanikumari et.al.,1985
Kalinga Vysya	192	0.1493	0.2215	0.4039	Lakshmi,1994
Relli	132	0.2430	0.2820	0.5953	Ramesh, 1992
Trivarnika	165	0.1346	0.2607	0.4304	Lakshmi,1994
Vadde	697	0.3460	0.2530	0.6870	Reddy et.al.,1987

Population	I	I_m	I_f/P_s	% I_f/P_s
Madiga	1.545	1.059	0.486	31.44
Mala	1.668	1.062	0.625	37.03
Reddy	0.747	0.424	0.323	43.20
Vysya(Urban)	0.600	0.389	0.211	35.17
Vysya(Rural)	0.934	0.524	0.410	43.90
Maheshwari	0.543	0.204	0.339	62.46

Reference: J S Murthy & V V Rao (1996)

Ind. J. Hum.Genet.2:1-11.

Table 4.60

Johnston and Kensinger's Indices

In Castes of Andhra Pradesh

Population	No	I_{me}	I	Source
Kshatriya	1500	0.0890	0 5538	Present study
Arya Vysya	183	0.1425	0.6920	Lakshmi,1994
Brahmin	450	0.1460	0.5890	RajaniKumari et al.,1985
Jalari	197	0.0430	0.3880	RajaniKumari et.al.,1985
Kaliga Vysya	192	0.0978	0.5412	Lakshmi,1994
Madiga	40	0.0520	0.8630	Reddy & Lakshmanudu,1979
Mala	325	0.0230	0.6100	Reddy & Lakshmanudu,1979
Relli	132	0.0300	0.6400	Ramesh,1992
Trivarnika	165	0.1375	0.6271	Lakshmi,1994
VishwaBrahmin	206	0.1465	0.5859	SubbaRao,1996

CHAPTER–5

DISCUSSION

The demographic data is the basic element of work for the population geneticist (Freire-Maia,1974). Marriage, fertility, mortality, migration and morbidity represent the most important areas for demography and population genetics. Socio economical and cultural variables act side by side with biological factors. population geneticist attempts to understand biological variation among different populations distributed in different geographical regions with varied socio-economic and cultural back ground, employing a variety of genetic and demographic parameters.

An understanding of the fertility and mortality trends is important in any demographic study. These are the prime factors controlling the growth of a population and also influence on the economic development of a country. A quick acceptance of family planning programmes by public contributes significantly in declining the rate of the population growth. Altering social structures and social norms effect fertility patterns. Fertility levels are lower in more developed than in less developed nations. In developed nations the fertility declined with modernization. Industrialization and urbanization, with their accompanying increased economic opportunities, higher levels of education, health and security and reorganization of the family are the major structural factors cited as influencing the negative relationship between fertility and modernization (Heer,1966; Davis,1967; Hohm,1975; Titlebaum,1975; Helen,1986; Koeslag,1986).

Demography is statistical study of human population. So, Study of genetic compositions of populations in the light of demographic changes in that population may be described as genetic demography. Genetic demography involves the study of mortality and fertility as a function of age. The application of mathematical models to the genetic models in a real population has started with Crow (1958), who made an interpretation of Fisher's (1930) " Fundamental theorem of natural selection" and termed it as "Index of selection".

Evolutionary changes are reflected in the differences of the demographic traits of a population and the rate of evolution depends on the available amount of genetic variation in fitness. "The rate of increase in fitness of any organism at any time is equal to its genetic variance in fitness at that time" (Fisher,1930). Changing fertility and mortality patterns due to socio-economic changes have a major effect on natural selection (Cavalli-Sforza,1971).

Results pertaining to present study are given in chapter 4 and chapter 5 deals with discussion concerned with the results.

Demography:

The first Indian data on menarcheal age was reported by Robertson,(1845), and this was followed by Gupta (1848), Das (1892) and Curjel (1920). The average menarcheal ages reported by them were 13.60, 12.38, 14.00 and 13.64 years respectively.

Mazer and Israel (1946) reported that both diet and hygiene influenced the onset of menarche. Malnutrition affected the skeletal growth and maturity and the onset of menarche was delayed by an average of two years (Drizen et.al.,1967). "An all India survey on growth and physical development of Indian infants and children " carried out by ICMR (1972) revealed that good nutrition influenced the growth and development to a large extent. Banerjee and Mukharjee (1961), Rakshit, (1960), Dubey and Srivastava (1965), Madhavan (1965), Logambal and Rao (1969), Shastree et.al.,(1974) have confirmed the above fact. Tanner (1964) has reported that identical twin sisters reach menarche with an average of two months apart and non identical twins sisters with an average of ten months apart. Bardhan (1962), from her investigation of Bengali girls, observed that weight increased gradually from 11th to 12th year. This increase in weight and height showed a clear picture of the physical development during the adolescent period. Report of ICMR (1972) and Bhalla and Srivastava (1974) also confirmed the above fact. One of the international reports (Damon,1974), showed association between the large body size and earlier menarche. The period of menarche is the age of maximal rate of growth. The earlier the onset of puberty, the more rapidly are the growth processes completed. Hence menarche is a fairly accurate barometer of physical development approaching mental and psychosexual maturity of pubertal girls.

Delay in age at menarche at higher altitude environment has been explained as a combined effect of low oxygen pressure, low nutrition intake and socio-economic status of that population (Malic,1986). Bhalla and Srivastava (1974) also reported that climate does play a role in the onset of menarche.

In the present study of Kshatriya women, early menarche is found to be more in urban area while late menarche more in rural area. Early menarche i.e., at 11th and 12th years is 2.07% and 8.90% respectively in the urban area while it is 1.18% and 4.71% in the rural area. Late menarche i.e., at 16th and 17th years is 7.5% and 1.76% respectively in rural areas while it is 4.39% and 0.25% respectively in urban areas.

The early maturity of urban girls may be because of the stress and strain to which they are subjected.

Nutritional factor could also be an important factor influencing the age at menarche. According to Mason (1939), chronic under feeding of the pre pubertal female leads to general retardation and even repression of sexual development. Mazer and Israel (1946) report that both diet and hygiene influenced the onset of menarche. The influences of these factors cannot be ruled out in causing differences between the urban and rural areas among the Kshatriya women of the present study. It has already been described in the earlier chapter that the difference between urban and rural areas with regard to mean menarcheal age is statistically significant ($t=4.2942; p<0.05$).

In the comparative study, it is observed that the mean menarcheal age among the Kshatriya women of the present study (13.86 in the pooled data of the urban and rural areas) is within the range observed in the other caste populations of Andhra Pradesh.

Menopause is an important milestone in the reproductive history of a women as the ability of the women to reproduce further is stopped with the onset of menopause. Concordance of monozygotic twins with regard to age at menopause (Susan, 1998) *than the dizygotic twins gives enough evidence of the role of* genetic factors in the onset of menopause. The most interesting point observed in the present study is that a considerable number of women (7.78%) in the rural area attained menopause before reaching 40 years of age, while a few of them attained menopause after 54 years. On the other hand, the women in the urban area attained menopause only between 40 and 54 years of age.

Comparatively the Kshatriya women attained menopause late ($\bar{x}$=46.18) than the populations such as Chakali ($\bar{x}$=44.45) and Ediga ($\bar{x}$=43.94).

Age at *marriage is important because of the fact* begetting children before marriage is unimaginable in India. Almost all the Kshatriya women of the present study got married before 25 years of age. In India the girls are married at an early age, especially in the rural area and the Kshatriyas of the present study are not an exception. About 11% of the women in rural area were married before reaching 15 years while 77% were married before 20 years. However, the trend is significantly different in urban area. A great majority of them got married between 15 and 19 years of age. It can safely be attributed to the education of the women in urban area.

Fertility and Mortality

The interval between age at marriage and first conception is the strongest factor affecting fertility in a population. In both urban and rural areas, in the present study population Kshatriyas, most of the women conceived for the first time between 14 and 19 years of age. A considerable fraction of 37.15% in the urban area and 23.59% in the rural area conceived between 20 and 24 years of age. The difference between the urban and rural areas with regard to mean age at first conception is statistically significant ($t=4.9832; p<0.05$).

Age at last conception is another important factor, which affects the fertility of a population. In the recent decades the age at last conceptions is subjected to great change. It is drastically advanced due to availability of family planning methods. Earlier, age at last conception used to be associated with age at menopause. But now a days it declined from age at menopause. Most of the Kshatriya women of the present study had their last conception between 20 and 24 years of age (69.27% in the urban and 62.24% in the rural area). Unlike in the age at first conception, the difference between the urban and the rural areas with regard to age at last conception is not significant statistically ($t=0.5492; p>0.05$).

Considering all age groups together the total number of conceptions among the Kshatriyas is considerably lower, in both urban and rural areas. The mean number of total conceptions in the urban area is 2.54 while it is 2.72 in the rural area. Considering women who completed fertility, the mean number of total conceptions is 3.92. This number also is a small number compared to certain other populations of Andhra Pradesh.

Mean number of pregnancies in some Indian populations is given in table no 5.1.

Table 5.1

Mean number of pregnancies among some Indian populations.

Populations	Mean number of Pregnancies	Source
Kshatriya	3.9239	Present Study
Arya Vysya	3.4645	Lakshmi,1994
Brahmin-I	4.3290	Srikumari,1985
Brahmin-II	5.7700	Sree Krishna,1989
Kalinga Vysya	4.0104	Lakshmi,1994
Trivamika	2.9636	Lakshmi,1994
Urban	4.2600	Rajanikumari,1980
Rural	5.2980	Rajanikumari,1980

Rajanikumari (1980) reported 4.26 mean number of pregnancies in urban area and 5.9 in rural area of Visakhapatnam district. Sri kumari (1985) reported 4.32 mean number of pregnancies among the Brahmins of Andhra Pradesh while Sree Krishna (1989) reported 5.77 mean number of pregnancies among Brahmin women who completed fertility. Lakshmi (1994) reported 3.46 mean number of pregnancies among the Vysyas of coastal Andhra

Pradesh. It is clear from table 5.1 that among the Kshatriyas of the present study the mean number of total pregnancies among those who completed fertility is very small.

The mean number of prenatal deaths is more or less the same in the urban and rural Kshatriya women (0.1841 and 0.1853 respectively). However, the mean number of abortions is slightly higher in the rural women (0.1324) than in the urban women (0.1268) while stillbirths are slightly higher among the urban women (0.0573) than among the rural women (0.0529). The difference between urban and rural areas with regard to any of these parameters is not significant. Srikumari (1985) reported prenatal mortality rate of 0.1359 per women among the Brahmins of Andhra Pradesh, a fairly large value. Sree Krishna (1989) reported 0.1818 among Rayalaseema Vaidiki Brahmin and 0.218 among Telaganya Vaidiki Brahmin. Lakshmi (1994) reported 0.1247, 0.0891 and 0.1209 prenatal deaths for women among the three Vysya groups Arya Vysya, Kalinga Vysya and Trivarnikas. Thus it is apparent that the prenatal mortality trends are almost in the same order in Andhra women including the study population, Kshatriyas.

It is evident from pre reproductive deaths that the medical care is more among the urban areas than in rural areas and it is matter of concern for health workers. The difference with regard to mean number of pre reproductive deaths between urban and rural Kshatriya women is significant statistically ($t=3.2229$; $p<0.05$). Sri kumari (1985) reported a mean number of 0.1149 pre reproductive deaths among the Brahmins of Andhra Pradesh while Sree Krishna

(1989) reported a mean of 0.1347 among the pooled data of Brahmins of Andhra Pradesh. Lakshmi (1994) reported a mean of 0.0962, 0.1299 and 0.1186 pre reproductive deaths among the Arya Vysya, Kalinga Vysya and Trivarnikas respectively. Thus the trends of pre reproductive deaths in the Kshatriya women are in line with trends observed in earlier studies.

Considering live births, the difference between the urban and rural areas is significant statistically ($t=2.4578; p<0.05$).

Family planning influences the number of children in any family. The State Government of Andhra Pradesh as well as Central Government of India has been giving more importance to family planning programmes to control the population growth. In general, the family planning programmes are successful in Andhra Pradesh, especially in urban areas. This is well evident in the live births among the Kshatriya women. The mean number of live births in general is around 2.444. It is higher in rural area (2.50) than in the urban area (2.36) and the urban–rural difference is statistically significant. Mean number of live births in general among the Kshatriyas (2.44) is lesser compared to several other populations. Srikumari (1985) reported a mean of 3.61 live births among the Brahmins of Andhra Pradesh, while Sree Krishna reported (1989) a mean of 5.05 from the same community. Lakshmi (1994) reported a mean of 3.46, 4.01 and 2.96 among three Vysya sub populations, Arya Vysya, Kalinga Vysya and Trivarnikas respectively. Thus it is clear that the Kshatriyas of Andhra Pradesh preferred small families.

The number of surviving children is the actual indication of the child care and medical facilities available and influences the population growth. The mean number of surviving children among the Kshatriyas in general is 2.26. It is high in rural women (2.56) and low in urban women (2.24). The urban-rural difference is statistically significant ($t=4.1715; p<0.05$).

Sterility effects the variability of fertility and provides scope for the action of natural selection via fertility differentials (Jackquard and Wand, 1976). The frequency of sterile women among the Kshatriyas is 1.27%. This is relatively low compared to other populations. Srikumari (1985) reported a frequency of 2.05% sterile women among the Brahmins of Andhra Pradesh, while Sree Krishna (1989) reported 6% in the same community. Lakshmi (1994) reported 2.33% sterility among the Arya Vysya of Andhra Pradesh.

Consanguinity, Fertility and Mortality

Consanguineous marriages are widely prevalent in India in general and South India and Western India in particular (Sanghvi, 1966; Dronamraju and Meerakhan, 1960; Ali, 1968; Chakravartti, 1968). In Northern India only few communities practice it (Goswami, 1970; Mukherjee, 1973). Early studies reported the effects of consanguinity such as elevated birth rates and high mortality (Schull, 1970; Reid, 1971) and some studies reported decreased fertility and increased mortality (Book,1957; Slatis et. al.,1958; Dronamraju and Meerakhan, 1963). Some later studies showed only moderate to slight impact of consanguinity (Schull and Neel,1972;Freire-Mia and Krieger,1975).

The frequency of consanguineous marriages in the present study is 21.13% in general. Among different types of consanguineous marriages first cousin type is high followed by uncle-niece type. The frequency of consanguineous marriages varies from 13.61% (Srikumari,1985) to 47.76% (Govinda Reddy,1985) in different parts of India. It is quite interesting that Sanghvi (1966) reported 25.61% consanguinity among the Brahmins of Andhra Pradesh, while Srikumari (1985) reported 13.61% and Sree Krishna (1989) reported a frequency of 19% consanguineous marriages among Brahmins of Andhra Pradesh. It is evident from the above facts that there is trend of decline in consanguineous marriages. This may be due to awareness of consequences of inbreeding as the population is educated more and more. It can also be due to increased facility of mobility which widens the area choice of selecting a bride or a groom.

The inbreeding coefficient for autosomal alleles (F_a) is 0.0155 among the Kshatriyas. It is 0.0106 among the Brahmins (Sri kumari,1985;Sree Krishna,1989). Lakshmi (1994) reported 0.0183, 0.0233 and 0.248 Fa values among the Arya Vysya, Kalinga Vysya and Trivarnikas respectively.

The inbreeding coefficient for sex linked alleles (F_s) is 0.0186 among the Kshatriyas. It is 0.0159 among the Brahmins (Sri kumari,1985). Lakshmi(1994) observed high values of F_s among the three Vysya populations of Andhra Pradesh (Arya Vysya-0.0253, Kalinga Vysya-0.0292 and Trivarnikas-0.0373).

A high frequency of both abortions and stillbirths is reported among the affinal marriages in the urban area than in the consanguineous marriages and a complete reverse trend to this in the rural area may be due to availability of better medical facilities and awareness of health care during the pregnancy in the urban area. Availability of medical facilities tempt the couples to go for medical termination of unwanted conceptions while this may not be possible in rural area.

The difference between consanguineous and non-consanguineous marriages with regard to abortions, stillbirths and total prenatal losses in both urban and rural areas is not statistically significant.

Genetic Load:

The inbreeding effects of reproductive wastage are tested through the exponential model of Smith (1967).

The measure for hidden genetic damage "B" is low in both urban and rural areas considering the effects of abortions. However, considering total prenatal deaths, the value of "B" is low in the urban area and more in the rural area. Estimate "B" could be low in urban area, since many of the deaths in consanguineous families due to infectious diseases are now low (due to better health care) and for which genetic susceptibility is thus less serious (Morton et.al.,1956). It is further supported by a low value of "A".

According to Cavalli Sforza and Bodmer (1971) estimate "A" decreases with increasing medical care but within it, the proportion of deaths whose cause is strictly genetic increases. Morton et.al.,(1956), Vogel and Motulsky (1982) cautiously admit that sociological concomitance of consanguineous marriages (Urban-Rural difference etc.,) may be confounded with genetic effects.

The genetic load (B/A ratio) indicates that the average gamete carries a number of deleterious genes, if distributed in a single individual and made homozygous, that would kill 2.5826 individuals before birth (based on prenatal deaths) and 4.0852 individuals before pre reproductive age (based on total pre reproductive deaths).

The total genetic damage is expressed by summation of the effects of all deleterious genes and hence lies between B and A+B. Considering total prenatal deaths a lethal equivalent between 0.1547 to 0.6546 per gamete or 0.3094 to 1.3092 per zygote in the Kshatriyas is obtained. In general the observed genetic load and lethal equivalents in the Kshatriya population are low when compared with some other studies on Japanese and Brazilians (Schull and Neel, 1972;Fraser and Mayo, 1974) and also South Indian Keralites (Kumar et.al.1967). The results of this study support the hypothesis that continued practice of inbreeding for several generations have resulted in the gradual elimination of deleterious genes by segregation (Sanghvi,1966; Rao and Inbaraj,1979 and 1980).

Index of Opportunity for Selection:

In developing countries like India there is a spectra of mass family planning programmes involving hormonal methods and sterilization camps to control the overcrowding. Changing mortality and fertility patterns due to major socio-economic changes have a profound effect on natural selection in human populations (Cavalli-Sforza and Bodmer,1971). Since early 1960s more than 50 investigations have undertaken into how family planning programmes may have changed the course of fertility, either that of acceptors or of the general population leading to differential fertility (Forest and Ross,1978). Changed socio-cultural conditions were stressed to have strongly affected mortality rates and fertility patterns in other important studies, (Crow, 1966; Cruz-Coke et.al., 1966; Matsunga,1966).

Despite the fact that numerous evaluations of this index have been made in different species (Crow,1961) there seems to be no doubt that from this point of view human beings can give the most complete information, with the possibility of nearly accurate historical reconstructions.

In the present study the reproductive performance of 193 Kshatriya women from rural area and 162 women from the urban area (total 355 women) who completed fertility were analyzed. The total index for natural selection is lower in the urban area (0.3558) than in the rural area (0.4690). In both the areas the fertility component is more than the mortality component.

Index of opportunity for natural selection based on fecundity characteristics (Johnston and Kensinger,1971) is higher than Crow's index. However, the percent of fertility differential's contributions to the measure of total selection decreased than in Crow's index.

The increased fertility differentials in the Kshatriya women suggest that when pre reproductive mortality is reduced, fertility might become major factor in the operation of the natural selection as is evident in some industrially developed populations of the United States of America. Further, the birth control and modern medical facilities tend to reduce the variance in fertility (Cavalli-Sforza and Bodmer,1971).

Comparing the relative contribution of fertility and mortality to the measure of selection (Crow's index) it is interesting that in the Kshatriyas of the present study, the contribution of fertility component is 76.85%, while in other studies of Jalaris (a low socio-economic population) the mortality component is 64.60%. The socio-economic positions of the two might be responsible for this opposing trend of fertility and mortality contributions. This perhaps corresponds to a transitional phase in the population with the impetus of improved health conditions in the Kshatriyas and the other well-placed socio-economic groups such as Brahmins and Vysyas.

It is relevant here to mention the study of Ulizzi et.al., (1979) and Terramatte et.al., (1979) who investigated the selection opportunities with the change in environment of Italy over a century and demonstrated the relevance of socio-economic and cultural changes to the evolution of selective patterns in our species.

CHAPTER-6

SUMMARY AND CONCLUSIONS

Genetic variation of human populations is a very important factor for their survival in changing environment and serves as a source for the natural selection to play its role in evolution. Though it is customary to talk of fitness of a gene, genotype, or phenotype with regard to a locus or character, selection acts on the individuals through survival or elimination of the individual in toto but not on the alleles alone. Therefore selection is studied and measured in terms of number of births and deaths rather than alleles alone.

Genetic demographic studies are important from this point of view. The present study is aimed at studying the demographic genetic profile of Kshatriya, a hitherto untouched endogamous caste population of Andhra Pradesh in this aspect.

The Kshatriyas are mainly distributed in coastal Andhra Pradesh in few pockets. The materials for the present study were collected from the four districts Vijayanagaram, Visakhapatnam, East Godavary, West Godavary where they are concentrated. Details of places of data collection have already been described in Chapter 3.

The Kshatriya is a warrior community and occupies second place hierarchially in traditional Varna system of Brahmin, Kshatriya, Vysya and Sudra.

Data were collected from 820 urban and 680 rural families. Information pertaining to genetic demography analysis was collected using a prescribed schedule and the data were analysed and presented in Chapters 4 and 5. The following are the salient features of the study.

1. The mean age at menarche is 13.75 years in the urban area and 13.99 in the rural area. It is 13.86 years in pooled data. The difference between the urban and rural areas is statistically significant.

2. The mean age at menopause is 46.38 in the urban area and 45.75 in the rural area. In the combined data it is 46.04.Unlike the *menarcheal age, the urban – rural difference of age at menopause* is not significant.

3. The mean age at marriage is less (17.00 years) in rural area than in urban area (17.95 years) and urban and rural difference is statistically significant. Education of the women may be an important factor for this aspect.

4. The mean age at first conception is also less in rural area (18.22) than in urban area (18.90) and the difference is statistically significant.

5. The mean age at last conception is almost the same in both urban and rural areas. This has drastically come down to about 23 years. This is mainly because of acceptance of family planning by the Kshatriya women.

6. Mean number of total conceptions, abortions, still births, and total prenatal deaths are almost the same in the urban and rural areas and the difference is not statistically significant.

7. Mean number of live births is more in rural area (2.54) than in urban area (2.36) and the difference is statistically significant.

8. Mean number of neonatal deaths, infantile deaths, juvenile deaths and total reproductive deaths are almost the same in rural and urban areas and do not differ significantly.

9. Mean number of surviving children in rural area is 2.55 while it is 2.24 in urban area and the difference is statistically significant.

10. The Kshatriyas practice consanguineous marriages to an extent of 21.13%. First cousin marriages are more, followed by uncle-niece type. Among the first cousins MBD type is more than FSD type.

11. The inbreeding coefficient is almost the same in the urban and rural areas. In the combined data 'F' for autosomal alleles is 0.0155 while it is 0.0186 for sex-linked alleles.

12. The difference between the affinal and consanguineous marriages with regard to means for total conceptions, still births and total prenatal deaths in the urban and rural areas as well as pooled data are not significant statistically. In general the effect of consanguinity is not significant with regard to mortality

13. While studying genetic load, the estimates of 'A' and 'B' are calculated after Smith (1967). The values of 'A' are more are less the same in the rural and urban areas considering abortions and prenatal deaths births. However 'B' values varied between the urban and rural areas for both abortions and prenatal deaths. Considering total pre reproductive deaths, the value of 'A' is higher in rural area (0.0697) than in the urban area (0.0455). However, 'B' value is higher in urban area (0.3311) than in rural area (0.2441).

The lower 'A' value for abortions and total prenatal deaths in urban areas could be because of better medical facilities. The 'B' values are high in urban area for abortions and total pre reproductive deaths. These could be attributed to high frequency of consanguineous marriages.

14. Considering total prenatal deaths, a lethal equivalent between 0.1547 to 0.6546 per gamete or 0.3094 to 1.3092 per zygote is obtained. In general the observed genetic load and lethal equivalents in the Kshatriya population are low compared to other studies from Japan, Brazil and some studies on South Indian populations. The results of the present study lend support to the hypothesis that continued practice of inbreeding for several generations might have resulted in gradual elimination of deleterious genes by segregation (Sanghvi,1966; Rao and Inbaraj,1979 and 1980).

15. The total index of opportunity for natural selection (Crow,1961) is lower in the urban area (0.3558) than in the rural area (0.4690). In both the areas the fertility component is more than the mortality component.

16. Index of opportunity for natural selection based on fecundity characteristics (Johnston and Kensinger,1971) is higher than Crow's index. However the percent of fertility differentials contributions to the measure of total selection decreased than in Crow's index.

These results suggest that when pre reproductive mortality is reduced, fertility might become major factor in the operation of natural selection. The Kshatriyas are perhaps in a transitional phase with the impetus of improved health conditions.

BIBLIOGRAPHY

BIBILIOGRAPHY

Ali,S.G.M.,(1968),

Inbreeding and endogamy in Kerala (India). Acta.Genet. (Basel) 18:369-379.

Arner,G.B.L., (1908),

Consanguineous marriages in the American Population. Columbia University studies in History, Economics and Public law. 31:1-99

Banerjee,D., and Mukherjee,S.S., (1961),

Menarche in Bengalee Hindu girls. J. Ind. Med. Assoc. 37:261-270.

Bardhan,A., (1962),

A short note on relationship between menarcheal age and certain anthropometric measurements. The Anthropologist. IX:25-30.

Babu,B.V., and Naidu,J.M., (1989),

A demographic profile of four Andhra caste Populations. Ind.J.Phys.Anthrop. & Hum.Genet.15:97-102.

Babu,B.V., Kusuma,Y.S., and Naidu,J.M., (1994),

Genetic load among four Andhra caste Populations Soc. Biol. 41:127.

Basu,S.K.,(1975),

Effects of consanguinity among North Indian Muslims. J.Pop.Res.2:57-68.

Basu,S.K.(1985),

Cited from health status of tribal women in India.

Social change 23(4) Dec 1993 p(19-39) Location SNDT Churchgate, Bombay

Basu,K., and Gupta,P.,(1979),

Menarche and its trend in India Ind J Phys Anthrop

& Hum Genet 5 27-42

Bemiss,S.M.,(1858),

Report on the influence of marriage of consanguinity upon offspring Trans Amer Med Assoc 11 319-425

Bhalla,M., and Srivastava,J.R.,(1974),

A prospective study of the age of menopause in Kanpur girls Indian Pediatrics XI 487-493

Bhaskar,S., Vasulu,T.S., and Damodaran,K.,(1986),

Demographic structure of Ediga A backward community of Chittoor district South India Ind J Anthrop & Hum Genet 12 51-59

Bittles, A.H., Mason, W.M., Greene, J, and Rao,N.A., (1991),

Reproductive behavior and health in consanguineous marriages, Science 252 789-794

Book,J.A.,(1956),

Genetic investigations in a Northern Swedish Population, the offspring of first cousin marriage Ann Eugen 21 191-221

Book,J.A.,(1957),

Genetical investigations in North Swedish Population Ann Hum Genet 20 239-250

Boerma,J.T., and Bicego,G.T.,(1992),

Preceding birth intervals and child survival, searching for path ways of influence stud Fam Plan 23 243

Bogue,D.J.,(1969),

Principles of Demography John Wiley and sons, Inc, New York

Cavalli-Sforza,L.L., and Bodmer,W.F.,(1971),

The Genetics of Human Populations W H Freeman & Co San Francisco, London

Caldwell, J. C., Reddy,P.H and Caldwell, P.A.T., (1983)

The cause of marriage change in South India Population Studies 37 343-362

Chakravartti,M.R.,(1968),

Consanguinity in India Z Morph Anthrop 60 170-183

Chakravartti,M.R.,KameshwarRao,N.V.,Satyanarayana,M.,and Veerraju, P.,(1971)

A note on inbreeding in Andhra Pradesh The East Anthrop 24 71-74

Chakravartti,M.R., and Renuka,Y.,(1970)

The trend of age at menarche in India J Soc Res 13 82-94

Charles,Cantor., (2000)

How many SNPs are enough? Gene letter Gene Sage-Archives, March 1 P No-3

Chowdhury,A.K.M (1981)

Infant deaths, determinants and dilemmas Scientific report No 206 ICDDR, B, Dhaka

Cook,R., and Hanslip,A.,(1966)

Mortality among offspring of consanguineous marriages in rural areas of East Jordon J Trop Pediat 11 95-96

Crow,J.F.,(1958)

Some possibilities for measuring Selection Intensities in man Hum Biol 30 1-13

Crow,J.F.,(1961)

Population genetics Am J Hum Genet 13(1) 137-150

Crow,J.F.,(1966)

The quality of People Human Evolutionary Changes

Bioscience 16 863-867

Crow,J.F., and Kimura,M.,(1970)

An Introduction to Population Genetics Theory Harper and Row New York

Curjel,D.F.,(1920)

The reproductive life of some Indian women Ind J Med Res 8 366-369

Curz-Coke,R., Cristofannini,A.P,. Aspillaga,M., and Biankani,F.,(1966)

Evolutionary forces in Human Populations in an environmental gradient in Africa,Chile Hum Biol 38 421-438

Damon,A.,(1974)

Larger body size and earlier menarche the end may be in sight Soc Biol 21 8

Darlington,C.D.,(1960)

Cousin marriage and evolution of breeding systems in man Heredity 16 297-331

Darwin,G.H.,(1875)

Marriage of first cousins in England and their effects J Stat Soc (London) 38 153-182

Das,B.M.,(1985)

Micro evolutionary trend in Northeast Indian tribes An overview In Genetic Differentiation in Human and other Animal Populations Y R Ahuja and J V Neel (eds) Indian Anthropological Association, Delhi 94-106

Das,K.N.,(1892)

Vide Banerjee and Mukherjee, J Med Assoc 1961 37 261-270

Davis,K.,(1967)

Population policy,will current programs succeed? Science 158 730-739

Dreizen,S.,et al.,(1967)

A comparison of skeletal growth and maturation in under nourished and well nourished girls before and after menarche J Pediat 70 256-263

Dronamraju,K.R., and Meerakhan,P.,(1960)

Inbreeding in Andhra Pradesh J Hered 51 239-242

Dronamraju,K.R., and Meerakhan,P.,(1961)

Inbreeding in Andhra Pradesh Proc 2nd Int Cong Hum Genet 1 126-130

DronamRaju,K.R., and Meerakhan,P.,(1963)

The frequency of effects of consanguineous marriages in Andhra Pradesh J Genet 58 387-401

Dubey,R.L., and Srivastava,R.P.,(1965),

Trend of menarche in 361 women of Uttar Pradesh

The Anthropologist, X 7-12

Eaton,J., and Mayer,A.,(1954)

Men's capacity to reproduce Hum Biol 25 1-58.

Fisher,R.A.,(1930)

The Genetical theory of Natural Selection (2^{nd} ed,1958) New York,Dover

Fisher,R.A.,(1949)

The Theory of Inbreeding Driver and Boyd Edinborough

Forest,J.D., and Ross,J.A.,(1978)

Fertility effects of family planning programs A methodical reviews Soc Biol 25 145-161

Fraser,G.R.,and Mayo,O.,(1974)

Genetic load in man (review) Hum Genet 23 83-110

Freire–Maia,N., and Krieger,H.,(1963)

A Jewish isolate in Southern Brazil effective population, inter marriage, fertility, inbreeding, mortality, twinning, sex-ratio, genetic load and total mutation rate Ann of Hum Genet 27 31-39

Freire–Maia,N.,(1963)

The load of lethal mutations in White and Negro Brazilian Populations II Second survey Acta Genet 13 199-225

Freire–Maia,N.,(1967)

Practice of consanguineous marriages and its genetic effects World Population Conference,1965 Vol II 474-477 United Nations, New York,1967

Freire–Maia,N., and Azeveda,J.B.C.,(1971)

The Inbreeding load in Brazilian Whites and Negroes as estimated with sib and cousin controls Am J Hum Genet 23 1-7

Freire-Maia,N.,and Krieger,H.,(1975)

Human Genetic studies in areas of high Natural radiation VIII Genetic load is not related to radiation Am J Hum Genet 27 385-393

Freire–Maia,N (1976)

Population Genetics and Demography Hum Hered

24 105-108

Freire–Maia,N.,(1976)

Genetic loads in man Hum Hered 26 95-104

Freire-Maia,N.,(1982)

Inbreeding levels in different countries Soc Biol 29

69-81

Golvachev,G.D., and Bokarians.,(1971)

On Intrauterine Selection by ABO Incompatibility with special reference to maternal age Hum Genet 12

342-347

Goldschmidt,E.,Cohen,T.,Block,N.,Keleti,L.and Wartski,S.,(1963)

Viability studies in Jews from Kurdistan In , Genetics of migrant and isolated populations E Goldschmidt (ed) Williams and Wilkins (New York) P 183-185

Gupta,M.,(1848)

On menstruations among Hindu females In webb's Pethologica Indica

Haldane,J.B.S.,(1937)

The effect of variation on fitness Amer Natur 71

337-349

Haldane,J.B.S (1954)

The measurement of natural selection Caryologia, 6,suppl 1 , 480-487

Heer,D.M.,(1966)

Economic development and fertility, Demography 3

423-424

Hobcraft,J, Mc Donald and Rustein,S (1985)

Child spacing Effects on infant and early child mortality Popul Index, 49 ,585

Hohm,C.F.,(1975)

Social security and fertility An international perspective Demography 12 629-644

Hussain,F.M.,(1971)

Endogamy in Egyptian Nubia J Biosoc Sci 3 251-257

ICMR.,(1972)

Growth and physical development of Indian infants and children Indian council of Medical Research New Delhi

Jacquard,A.,(1974)

The genetic structure of Populations Biomathematics Vol 5 Springer, New York

Jacquard,A., and Ward,R.H.,(1976)

The genetic consequences of changing reproductive behaviour J Hum Evol 5 139-154

Jha,A.P.,(1997)

Genes and Evolution, Macmillan India Ltd, New Delhi

Johnston,F.E, and Kensinger,K.M.,(1971)

Fertility and mortality differentials and their implications for *micro-evolutionary change among Cashinahua* Hum Biol 43 356-364

Lakshmi,N.,(1994)

Microevolutionary Genetic Differentiation in three endogamous populations of Andhra Pradesh

Ph D, thesis Andhra University, Visakhapatnam (Unpublished)

Larrine,P., and Waller,R.K.,(1946)

Erythroblastosis foetalis in the first born Journal of Haematology 1 143

Li,C.C., (1963)

The way the load works Am J Hum Genet 15 316-321

Logambal,A., and Rao.,(1969)

Age of menarche in Madras state J Obstet & Gynec 19 490-493

Lue,N,Thang.N.M., Swenson,I., and Bichsan,P.,(1993)

Selected determinants of fertility in Vietnam, age at marriage, marriage to first birth interval and age at first birth J Biosoc sci 25,303

Madhavan,S (1965),

Age at menarche of south Indian girls, belonging to the states of Madras and Kerala Ind J Med Res, 53

669-673

Magnus,P., Berg,K., and Bjerkedal,T.,(1985)

Association of parental consanguinity, birth weight, increased rate of early death, and congenital malformations Clin Genet 28 335-342

Malecot,G.,(1948)

Les mathematiques de l heredite Paris,Masson Cited Cavalli-Sforza and Bodmer The Genetics of Human Populations W H Freeman and Co San Francisco and London

Marcallo,F.A.N., Freire-Maia,N., Azevedo,J.B.C., and Simoer,I.A.,(1964),

Inbreeding effects on mortality and morbidity in South Brazilian Population Ann Hum Genet 27 203-218

Malhotra,K.C.,(1978),

Morphological composition of the people of India J Hum Evol 7 45-63

Malhotra,K.C., (ed) (1988),

Statistical Methods in Human Population Genetics

Indian Institute of Bio-Social Research and Development

Eka press, Calcutta

Malic,S.L., and Hauspie,R.C.,(1986),

Age at menarche among high altitude Bods of Ladakh (India) Hum Biol 58 541-548

Mason,K.E.,(1939),

Sex and internal secretions in Vitamins and the Sex Glands (ed E Allen), Baltimore

Matsunga,E.,(1966),

Possible genetic consequences of family planning J Am Med Assoc 198 533-540

Mazer,C and Israel,S.L (1946),

Puberty and adolescence in diagnosis and treatment of menstrual disorders Harper and Row Publishers

Morton,N.E.,Crow,J.F.,and Muller,H.J.,(1956),

An estimate of the mutation damage in man from data on consanguineous marriages. Proc. Natl. Acad. Sci. 42:855-863.

Morton,N.E.,Crow,J.F.,and Muller,H.J.,(1965),

An estimate of the mutation damage in man from data on consanguineous marriages. Proc. Natl. Acad. Sci. 42 :855-863.

Mosby's Medical dictionary.,(1992),

2nd edition, Galgotia publications pvt ltd.

Mukherjee,D.P., Papa,Rao,A., and Govinda Reddy,P.,(1974).

Effects of consanguineous marriages on fertility and morbidity. Paper submitted to demographic conference New Delhi.

Muller,H.J.,(1950),

Our load of mutations. Am.J. Hum. Genet.2:111-176.

Muller,H.J.,(1958),

Our load of mutations Am.J.Hum.Genet.2:111-176.

Murty,J.S., and Jamil,T.,(1972),

Inbreeding load in the newborn of Hyderabad. Acta.Genet.Med. Gamellol.21:327-331.

Murty,J.S., and Rao, V.V.,(1996),

Effects of Inbreeding on mortality and other traits in socio.economically divergent castes of Andhra Pradesh. Ind.J.Hum.Genet.2:1-11.

Peritz,E.,(1971),

A statistical study of the intra uterine selection factors related to the ABO system II the analysis of foetal mortality data Ann Hum Genet ,34 389-394

Pearson,K.,(1902),

Assortive mating in man Biometrika 2 481-498

Philippe,P.,(1974),

Amenorrhea, intra-uterine mortality and parental consanguinity in an isolated French- Canadian Population Hum Biol 46 405-424

Rahman,M.M., Kabir., and Amin,R., (1996),

Relationship between survival status of first child and subsequent child death J Biosoc Sci 28 185-191

Rajanikumari,J.,(1980),

Demo Genetic Study of Human Sex-Ratio in Visakhapatnam District,(A P, India) Ph D thesis Andhra University, Waltair

Rajanikumari,J., and Rao,T.V.,(1985),

Cosanguinity effects on fertility and mortality in Andhra Pradesh, South India Personal communication

Rajeswari,G.R., Busi,B.R., Murty,J.S, Rao,V.V., and Narahari,S.,(1992),

Selection intensities and consanguinity in the Yadava and Vadabalija, of Visakhapatnam, Andhra Pradesh, India, Soc Biol 39 316-319

Rakshit,S.,(1960),

A short note on Menarcheal age of Assamese Girls

Man in India 40 52-55

Ramesh,M.,(1992),

A Genetic Study of the Rellis Ph D thesis, Andhra University, Waltair

Rao,P.S.S.,and Inbaraj,S.G.,(1977),

Inbreeding in Tamilnadu, South India Soc Biol 24 281-288

Rao,P.S.S., and Inbaraj,S G.,(1977),

Inbreeding effects on human reproduction in Tamilnadu of South India Ann Hum Genet 41 87-89

Rao,P.S.S., and Inbaraj,S.G.,(1979),

Trends in human reproductive wastage in relation to long term practice of inbreeding Ann Hum Genet , 42 401-413

Rao,P.S.S.,and Inbaraj,S.G.,(1980),

Inbreeding effects on fetal growth and development

J Med Genet 17 27-33

Rao,P.S.S.,(1983),

Religion and intensity of inbreeding in Tamil Nadu, South India Soc Biol 30 413-432

Rao,V.R., and Sathe,M.,(1991),

Estimating Genetic load in some tribes of Maharastra Ind J Phys Anthrop & Hum Genet 17 15-20

Rao,V.V., and Murty,J.S.,(1984),

Selection intensities and inbreeding among some caste groups of Andhra Pradesh Soc Biol 31 114-119

Rao,V.V., and Murthy,J.S.,(1986),

Mortality load disclosed by inbreeding in different castes of Andhra Pradesh Hum Biol 55 699-708

Rao,P.S.S., and Richard,J.,(1999),

An Introduction to Biostatistics A Manual for students in Health Sciences(3rd edition) Prentice-Hall of India Pvt Ltd

Reddy,B.M.,Chopra,V.P.,and Malhotra,K.C.,(1987),

Opportunity for natural selection with special reference to population structural measures among the Vadde Ann Hum Biol 14 249-261

Reddy,P.Govinda.,(1981),

Social Aspects of Consanguineous Marriages Ph D dissertation University of Madras

Reddy,P.C., and Lakshmanudu,M.,(1979),

Indices of Opportunity of selection in Mala, Madiga and other Indian Populations J Ind Anthrop Soc 14 245-252

Reddy,V.Rami., and Padmanabha.Naidu.G.,(1978),

Effects of consanguinity on fertility and mortality in the Gampa sati Kammas of Andhra Pradesh Med Genet in India 2 151-156

Reddy,P.G.,(1986),

Effects of inbreeding on mortality a study among three South Indian communities Hum Biol 57 47-59

Reddy,P.G.,(1986),

Effects of consanguineous marriages on fertility and infant mortality among Reddy and Mala of Southern Andhra Pradesh, Ind J Phys Anthrop & Hum Genet,

13 43-49

Reddy,P.G.,(1987),

Effects of consanguineous marriages of fertility among three endogamous groups of A P Soc Biol 34 68-77

Reddy,B.M.,(1992),

Inbreeding effects on reproductive outcome: A study *based on a large sample from the endogamus* Vadde of Kolleru lake, Andhra Pradesh, India. Hum. Biol. 64:

659-682.

Reid,R.M (1971)

Marriage patterns, demography and population genetics in South Indian caste: A Study of Inbreeding in a Human Population. Ph.D. dissertation. University of Illinois at Urbana Campaign.

Reid,R.M.,(1973),

Social structure and inbreeding in a South Indian caste. In N.E.Morton (ed) Genetic structure of Populations. Population Genetics Monographs. Vol iii. University of Hawaii. Honolulu.

Reid,R.M.,(1976),

Effects of consanguineous marriages and inbreeding on couple fertility and offspring mortality in rural areas of Sri Lanka. Hum.Biol.48:139-146.

Roberts,D.F., and Bonne,B.,(1973),

Reproduction and Inbreeding among the Samaritans.

Soc.Biol.20:64-67.

Robertson,J.,(1845),Vide Banarjee and Mukherjee,

J.Ind.Med.Assoc.. 1961, 37:261-270.

Roychoudhury,A.K.,(1983),

Genetic polymorphisms in Human Populations in India. In: Peoples of India some Genetical aspects.Indian Council of Medical Research,New Delhi.

Dr G.V.Satyavathi (ed), 1-30.

Sanghvi,L.D.,Vaide.D.S., and Master,H.R.,(1956),

Frequency of consanguineous marriages in twelve endogamus groups in Bombay. Acta. Genet. Etstat. Med. 6:41-49.

Sanghvi,L.D.,(1966),

Inbreeding in India. Eugen.Quart.13:291-301.

Sanghvi,L.D.,(1975),

Inbreeding in India and its consequences. Cited from

Dr.Emery, et.al.,Proceedings of the seminar on Medical Genetics,1975.Osmania University, Hyderabad, India.

Sanghvi,L.D.,and Notani,P.P.,(1978),

Effects Of Inbreeding on congenial malformations.

Ind.J.Hered.10:23-26.

Sanghvi,L.D.,(1982),

Inbreeding in India. Soc. Biol. 20: 106-17.

Schull,W.J and Neel,J.V (1965)

The effects of Inbreeding in Japanese children.Harper and Row, New York.

Schull,W.J and Neel,J.V (1966)

Some further observations on the effects of inbreeding on mortality in Kure, Japan. Am. J. Hum. Genet. 18:144-152

Schull,W.J.,Komatsu,I.,Nagganoh.,and Yamamoto,M.,(1968),

Hirado: Temporal trends in inbreeding and fertility Proc. Natl. Acad. Sci.(USA).50:671-679.

Schull,W.J., Nagganoh., and Yamamotot,M., (1970),

The effects of parental consanguinity and Inbreeding in Japan.1.stillbirths and pre reproductive mortality. Am. J. Hum. Genet. 22: 239-262.

Schull,W.J., and Neel,J.V.,(1972),

The effects of parental consanguinity and inbreeding in Hirado, Japan.V summary and interpretation. Am. J. Hum. Genet. 26: 625-653.

Seemanova,E.,(1971),

A study of children of Incestuous matings. Hum. Hered..21:108-128.

Shastree,U.S., Malhotra,K.C.,and Kanhere, G.M., (1974),

Trend of Menarche in seven Maharashtrian endogamous groups. Human Population Genetics in India. Proc. First Conf. Ind. Soc. Hum. Genet. 1: 240-250.

Sivaram,M., Ricahard,J., and Rao,P.S.S.,(1995),

Early marriage among rural and urban females of South India. J.Biosoc.Sci.27:325-331.

Slatis,H.M., Reis,R.M., and Hoene,R.E.,(1958),

Consanguineous marriages in Chicago region.Am. J. Hum. Genet..26: 625-653.

Smith,C.J.,(1967),

Note on paper "Consanguineous Marriages and Genetic Load due to Lethal Genes in Kerala". Ann.Hum.Genet.31:146.147.

Snider,H.,MacGregor,A.J., and Spector,T.D.,(1998),

Genes control the cessation of a woman's reproductive life a twin study of hysterectomy and age at menopause J Clin Endocrinol Metab 683 1875-1880

Sree Krishna,V.,(1989),

Genetic Diversity among Endogamous Sub Groups of Brahmins Ph D thesis Osmania University, Hyderabad

Sree Krishna,V., and Murty,J.S.,(1991),

Demographic diversity among Brahmins of Andhra Pradesh (In) Genetic studies in India – impact of Haldane (Ed) Murty J S Osmania University, Hyderabad, 121-137

Srikumari,C.R.,(1985),

A Study of Natural Selection and Genetic Adaptation among the Four Endogamous Subpopulations of Andhra Brahmins

Ph D thesis Andhra Univesrsity, Visakhapatnam

Srikumari,C.R., Rajanikumari,J., and Rao,T.V.,(1985),

Variability of genetic load with changing socio cultural environment Hum Hered 1985 35 383-93

Stern,C.,(1960),

Principles of Human Genetics 2nd ed W H Freeman and Co San Francisco and London

Stevenson,A.C.,Johnston,H.A.,Stewart,M.I.P.,and Golding,D.R.,(1966),

Congenital malformalations A report of a study of series of consecutive births in 24 centres

Supplement to Vol 34 of the Bulletin of W H O Cited from Master-Nathaniel et al ,1968

Subba Rao,I.,(1996),

A Population Ggenetic Study of the Viswa Brahmins. Ph.D thesis Andhra University (Unpublished)

Susan,A.Treloar.,(1998),

Genetic influences on the age at menopause.The Lancet.Oct 3.

Sutter,J., and Tabah,L.,(1952),

Effects de la consanguinite et de l endogamic Population (Paris).7:249-266.

Talukdar,S.,(1977),

On age at menopause in India.Man in India.57:345-350.

Tanner,R.E.S.,(1958),

Fertility and child mortality in cousin marriages: a study on Moslem community in East Africa. Eugenics Review.49:197-199.

Tanner,J.M.,(1962),

Growth at Adolescence. Second edition. Blackwell Scientific Publication, Oxford.

Tanner,J.M.,(ed).,(1960),

Genetics of Human growth. Third annual conference. Ind.Soc.Hum.Gen.

Tanner,J.M.,(ed).,(1962),

Age at Menarche among Nigerian school girls with a note on their height and weight from age 12-19 years. Hum.Biol.34:187-196.

Tanner,J.M.,(1964),

Hormonal, genetic and environmental factors controlling growth. Hum.Biol.344-345.

Teitelbaum,M.S.,(1970),

Factors affecting the sex ratio in large Populations

J Biosoc Sci Suppl 2 61-71

Teitelbaum,M (1975)

Relevance of demographic transition theory for developing countries Science 188 422-425

Terrenato,L.,Ulizzi,L., and San Martini,A.,(1979),

The effects of demographic transition on the opportunity for selection changes during the last century in Italy Ann Hum Genet 42 391-399

Ulizzi,L.,San Martini,A., and Terrenato,L.,(1979),

Changes in selection opportunities with changing environment regional heterogeneity in Italy Ann Hum Genet 43 137-141

Veerraju,P.,(1978),

Consanguinity in tribal communities of Andhra Pradesh In Medical Genetics in India Iswar C Varma(ed) Vol 2, Auroma Enterprises Pondicherry

Vogel,F., and Motulsky,A.G.L.,(1982),

Human Genetics problems and approaches PP 423-429 Springer, Berlin

Wright,S.,(1921),

Systems matings, I, ii, iii, iv and v Genetics 6 111-1278

Wright,S.,(1968),

Coefficients of inbreeding and reationship Am Natur ,

56 330-338

Wright,S.,(1968),

Evolution and the Genetics of Populations. Vol. 1 Genetics and Biometric Foundations.The University of Chicago press. Chicago.

Yamamoto,M.,Wada,T., and Watana,B.E.,(1972),

Genetic polymorphism in four isolated communities in Kinki district-Japan. J.Hum.Genet.17:273-285.

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A STUDY ON GENETIC DEMOGRAPHY OF THE KSHATRIYAS

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CHAPTER-6

SUMMARY AND CONCLUSIONS

Genetic variation of human populations is a very important factor for their survival in changing environment and serves as a source for the natural selection to play its role in evolution. Though it is customary to talk of fitness of a gene, genotype, or phenotype with regard to a locus or character, selection acts on the individuals through survival or elimination of the individual in toto but not on the alleles alone. Therefore selection is studied and measured in terms of number of births and deaths rather than alleles alone.

Genetic demographic studies are important from this point of view. The present study is aimed at studying the demographic genetic profile of Kshatriya, a hitherto untouched endogamous caste population of Andhra Pradesh in this aspect.

The Kshatriyas are mainly distributed in coastal Andhra Pradesh in few pockets. The materials for the present study were collected from the four districts Vijayanagaram, Visakhapatnam, East Godavary, West Godavary where they are concentrated. Details of places of data collection have already been described in Chapter 3.

The Kshatriya is a warrior community and occupies second place hierarchially in traditional Varna system of Brahmin, Kshatriya, Vysya and Sudra.

Data were collected from 820 urban and 680 rural families. Information pertaining to genetic demography analysis was collected using a prescribed schedule and the data were analysed and presented in Chapters 4 and 5. The following are the salient features of the study.

1. The mean age at menarche is 13.75 years in the urban area and 13.99 in the rural area. It is 13.86 years in pooled data. The difference between the urban and rural areas is statistically significant.

2. The mean age at menopause is 46.38 in the urban area and 45.75 in the rural area. In the combined data it is 46.04.Unlike the *menarcheal age, the urban – rural difference of age at menopause* is not significant.

3. The mean age at marriage is less (17.00 years) in rural area than in urban area (17.95 years) and urban and rural difference is statistically significant. Education of the women may be an important factor for this aspect.

4. The mean age at first conception is also less in rural area (18.22) than in urban area (18.90) and the difference is statistically significant.

5. The mean age at last conception is almost the same in both urban and rural areas. This has drastically come down to about 23 years. This is mainly because of acceptance of family planning by the Kshatriya women.

6. Mean number of total conceptions, abortions, still births, and total prenatal deaths are almost the same in the urban and rural areas and the difference is not statistically significant.

7. Mean number of live births is more in rural area (2.54) than in urban area (2.36) and the difference is statistically significant.

8. Mean number of neonatal deaths, infantile deaths, juvenile deaths and total reproductive deaths are almost the same in rural and urban areas and do not differ significantly.

9. Mean number of surviving children in rural area is 2.55 while it is 2.24 in urban area and the difference is statistically significant.

10. The Kshatriyas practice consanguineous marriages to an extent of 21.13%. First cousin marriages are more, followed by uncle-niece type. Among the first cousins MBD type is more than FSD type.

11. The inbreeding coefficient is almost the same in the urban and rural areas. In the combined data 'F' for autosomal alleles is 0.0155 while it is 0.0186 for sex-linked alleles.

12. The difference between the affinal and consanguineous marriages with regard to means for total conceptions, still births and total prenatal deaths in the urban and rural areas as well as pooled data are not significant statistically. In general the effect of consanguinity is not significant with regard to mortality

13. While studying genetic load, the estimates of 'A' and 'B' are calculated after Smith (1967). The values of 'A' are more are less the same in the rural and urban areas considering abortions and prenatal deaths births. However 'B' values varied between the urban and rural areas for both abortions and prenatal deaths. Considering total pre reproductive deaths, the value of 'A' is higher in rural area (0.0697) than in the urban area (0.0455). However, 'B' value is higher in urban area (0.3311) than in rural area (0.2441).

The lower 'A' value for abortions and total prenatal deaths in urban areas could be because of better medical facilities. The 'B' values are high in urban area for abortions and total pre reproductive deaths. These could be attributed to high frequency of consanguineous marriages.

14. Considering total prenatal deaths, a lethal equivalent between 0.1547 to 0.6546 per gamete or 0.3094 to 1.3092 per zygote is obtained. In general the observed genetic load and lethal equivalents in the Kshatriya population are low compared to other studies from Japan, Brazil and some studies on South Indian populations. The results of the present study lend support to the hypothesis that continued practice of inbreeding for several generations might have resulted in gradual elimination of deleterious genes by segregation (Sanghvi,1966; Rao and Inbaraj,1979 and 1980).

15. The total index of opportunity for natural selection (Crow,1961) is lower in the urban area (0.3558) than in the rural area (0.4690). In both the areas the fertility component is more than the mortality component.

16. Index of opportunity for natural selection based on fecundity characteristics (Johnston and Kensinger,1971) is higher than Crow's index. However the percent of fertility differentials contributions to the measure of total selection decreased than in Crow's index.

These results suggest that when pre reproductive mortality is reduced, fertility might become major factor in the operation of natural selection. The Kshatriyas are perhaps in a transitional phase with the impetus of improved health conditions.